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ABSTRACT

This report describes a nationally coordinated program development project whose purpose was to catalyze the implementation of needed postsecondary educational programs in the field of nuclear medicine technology (NMT). The NMT project was carried out during the six year period 1968-74 in cooperation with more than 36 community/junior colleges and other institutions in 22 states. It involved more than 400 hospitals, 12 industrial employers, 29 universities, and particularly close cooperation with leading nuclear medicine practitioners, major NMT professional societies, and the American Medical Association on Medical Education. In addition, this report generalizes on the difficult problems which emerging occupations present to our nation's educational system and makes recommendations for systematic new approaches to keep our education relevant to the changing needs of new and emerging occupational fields. (Author/EB)

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FINAL REPORT

Project No. V-257995
Grant No. OEG-0-8-070313-4602(085)

DEVELOPMENT OF CAREER OPPORTUNITIES FOR TECHNICIANS IN THE NUCLEAR MEDICINE FIELD

Technical Education Research Centers, Inc.
44 Brattle Street
Cambridge, Massachusetts 02138

January, 1975

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FOREWORD

Implementing needed educational programs in new and emerging occupational fields presents a serious and growing challenge to our educational system. Large numbers of our young people lack preparation for the rapidly changing occupational needs of employers and are therefore unemployed or underemployed. Increasingly rapid technological and social changes are constantly creating new occupational fields where tens of thousands of excellent career opportunities are available but where few if any occupational education programs exist or are even planned. Since many of these emerging occupations focus on problems critical to our society they are among the fastest growing fields and in a few years may be major employers of technicians and skilled workers. They require greatly increased numbers of well prepared technical and other support personnel at many levels of ability and preparation and can provide excellent lifelong careers for those who receive occupational education in these fields.

Despite rapidly developing employment and career opportunities in new and emerging occupations individual schools and state educational planners find it very difficult to develop programs in these areas. As a result there is often a ten-year lag between the needs of employers and implementation of responsive occupational and career education programs in these fields. This imbalance between employment opportunities and available educational programs is harmful to students, to employers, and to our nation.

The reasons that individual schools and state systems find it so difficult to respond to the needs of rapidly emerging occupations are inherent in the nature of these new occupational fields which typically present a confused picture to school administrators, parents, and students. The confusion and uncertainties include.

1. A lack of consensus among employers as to job definitions and career ladders in the new field;

2. Resulting confusion as to educational specifications for the new field;

3. Uncertainty as to how many local employment opportunities exist in the emerging field and as to whether new educational programs are justified in terms of numbers of students; and

4. A lack of available program planning materials, instructional materials, and experienced teachers necessary to implement needed new programs.

In the face of these uncertainties it is indeed difficult for schools to develop programs in emerging fields. It is particularly difficult for schools to establish priorities which enable them to decide which of several possible emerging occupational programs should be established in light of budget constraints.

It is seldom feasible or economical for individual schools or individual states to carry out the extensive research and development required to resolve these uncertainties themselves and to provide a sound basis for the planning and implementation of needed educational programs in rapidly emerging occupational areas. There is indeed seldom sufficient experience in any one community or state to adequately encompass the many rapidly changing aspects of an emerging occupation. Such a task can only be accomplished, if at all, on a national basis by involving relevant leaders in education, industry, and the professions throughout the country in a cooperative effort.

This report describes such a cooperative effort--a nationally coordinated program development project whose purpose was to catalyze the implementation of needed postsecondary educational programs in the field of nuclear medicine technology. Nuclear medicine technology (NMT) is an emerging health technology requiring the development of unique collaborative educational programs involving close cooperation between schools and nearby hospitals. The NMT project was carried out during the six year period 1968-74 in cooperation with more than 36 community/junior colleges, and other institutions in 22 states. It involved more than 400 hospitals, 12 industrial employers, 29 universities and particularly close cooperation with leading nuclear medicine practitioners, six major NMT professional societies and the AMA Council on Medical Education.

The NMT project was closely coordinated with three related national program development projects being carried out by TERC at the same time in the new and emerging fields of biomedical equipment technology (BMET), electromechanical technology (EMT), and laser/electro-optic technology (LEOT). Since this is the last of the Final Reports to be submitted on these four related projects it is appropriate that this report summarize the common experience of all four projects and discuss the implications of this experience for other new and emerging occupational fields. In addition to reporting on the NMT project, this report therefore generalizes on the difficult problems which emerging occupations present to our nation's educational system and makes recommendations for systematic new approaches to keep our education relevant to the changing needs of new and emerging occupational fields.

ACKNOWLEDGMENTS

The Nuclear Medicine Technology (NMT) Project has involved more than one thousand individuals, institutions and organizations over a six year period. It would obviously be impossible and inappropriate to attempt to recite their contributions. Although credit is due to all of them, only a few of these contributors are listed in the appendix.

The unique collaboration between the NMT project and the major professional societies concerned with nuclear medicine has been a vital source of strength and inspiration to the project. Throughout TERC's work in allied health fields the Department of Allied Health Medical Professions and Services of the American Medical Association has provided guidance and liaison assistance. Special thanks are also due to the American College of Radiology; American Society of Clinical Pathologists; Society of Nuclear Medicine Technologists; American Society of Radiologic Technologists; American Society of Medical Technologists; and Society of Nuclear Medicine for their guidance, support and assistance.

The project is particularly indebted to the more than fifty professional leaders in nuclear medicine and education who contributed so generously of their time as an Advisory Committee in the development and reviewing of the NMT Curriculum Guide and whose names are listed in the appendix. Special thanks should also be made to the administration, deans of instruction, teachers, and staff of the community/junior colleges, technical institutes, and other educational institutions, together with their collaborating hospitals, which have implemented or are planning NMT programs in conjunction with the NMT project.

In terms of continued support and encouragement for the project, credit is due to Dr. Walter J. Brooking and others of the U. S. Office of Education staff who provided valuable guidance and assistance throughout. Key TERC project personnel who provided research direction for the project include Dr. P. John Cadle and Dr. Joseph L. Hozid. Many other TERC staff personnel have provided vital inputs to the Project. Ms. Diana Katz played a major role in the preparation and editing of NMT project products.

Despite many individual contributions, the NMT Project was in essence a unique collaborative venture by researchers, developers, disseminators, implementors, educators, practitioners, employers, and many others concerned with the emerging field of nuclear medicine technology. Only by the combined efforts of all of them has the Project been able to contribute so significantly to improving the quality and availability of NMT education throughout the nation.

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SUMMARY

The frequent emergence and rapid growth of new occupational areas as a result of technological and social change is a normal and healthy phenomenon in our increasingly dynamic and complex society. In order to remain responsive to national needs our educational system must develop the capability of implementing needed educational programs in new and emerging occupational fields as these needs develop.

To address this urgent problem, beginning in 1966, Technical Education Research Centers (TERC), undertook national program development efforts in several new and emerging occupations under the sponsorship of the U. S. Office of Education. These coordinated program development efforts were carried on in cooperation with community/junior colleges, technical institutes, and other institutions throughout the country. A major objective of this experimental thrust was to develop a systematic approach to assist our schools to respond more effectively to the growing national need for programs in new and emerging occupational fields.

Four typical new and emerging occupational fields were the focus of the experimental thrust--biomedical equipment technology, electromechanical technology, laser and electro-optical technology, and nuclear medicine technology. The specific problems in each field were quite different in terms of technology, labor market demands, professional associations, and interested educational institutions. However, each field faced the common problems of all rapidly growing new and emerging occupational fields. In each field because of rapid technological and social changes there existed employment opportunities for thousands of trained technicians and skilled personnel. Yet virtually no educational programs had been implemented to prepare students for these new careers and few if any programs were being planned. It was clear in each field that unless some new approach was taken the usual ten to fifteen years would elapse before adequate educational programs could be implemented to meet the needs of employers and students in these fields.

It was proposed by TERC that an effective approach to the problem in each of the four fields could be achieved through a new type of research, development, and dissemination project whose overall purpose was to catalyze the implementation of many needed educational programs in a particular occupational field. Such a project would involve a small project staff working cooperatively with interested schools, and with leading employers and professionals in that field throughout the country over a period of several years. It was planned that each coordinated program development project would include four successive but overlapping phases: (1) Survey of Needs and Resources, (2) Development of Pilot Programs, (3) Expanded Program Development, and (4) Dissemination/Implementation.

Each project sought to develop the most effective strategies and techniques to catalyze the implementation of new programs in its particular field. As a result each project followed a somewhat different model of research, development, and dissemination. At the same time all four projects communicated frequently in an effort to develop generalizeable approaches which would be effective in catalyzing new program development in any emerging occupational field.

The NMT project was initiated in July, 1968 in response to an increasingly serious imbalance between the rapidly growing needs for nuclear medicine technicians on the one hand and the lack of NMT programs in community/junior colleges, technical institutes and other educational institutions. Nuclear medicine technicians (NMTs) are needed to assist nuclear medicine physicians by performing a variety of clinical duties involved with nuclear medicine procedures. They prepare and measure the radiopharmaceutical doses for administration to patients and operate specially designed equipment.

Prior to 1968 most NMTs were trained on an individual basis in hospitals. To meet the rapidly growing national requirements of NMTs it became necessary to move NMT education into the mainstream of the nation's educational system. This required developing new kinds of comprehensive associate degree level NMT programs involving close collaboration between educational institutions and nearby hospitals.

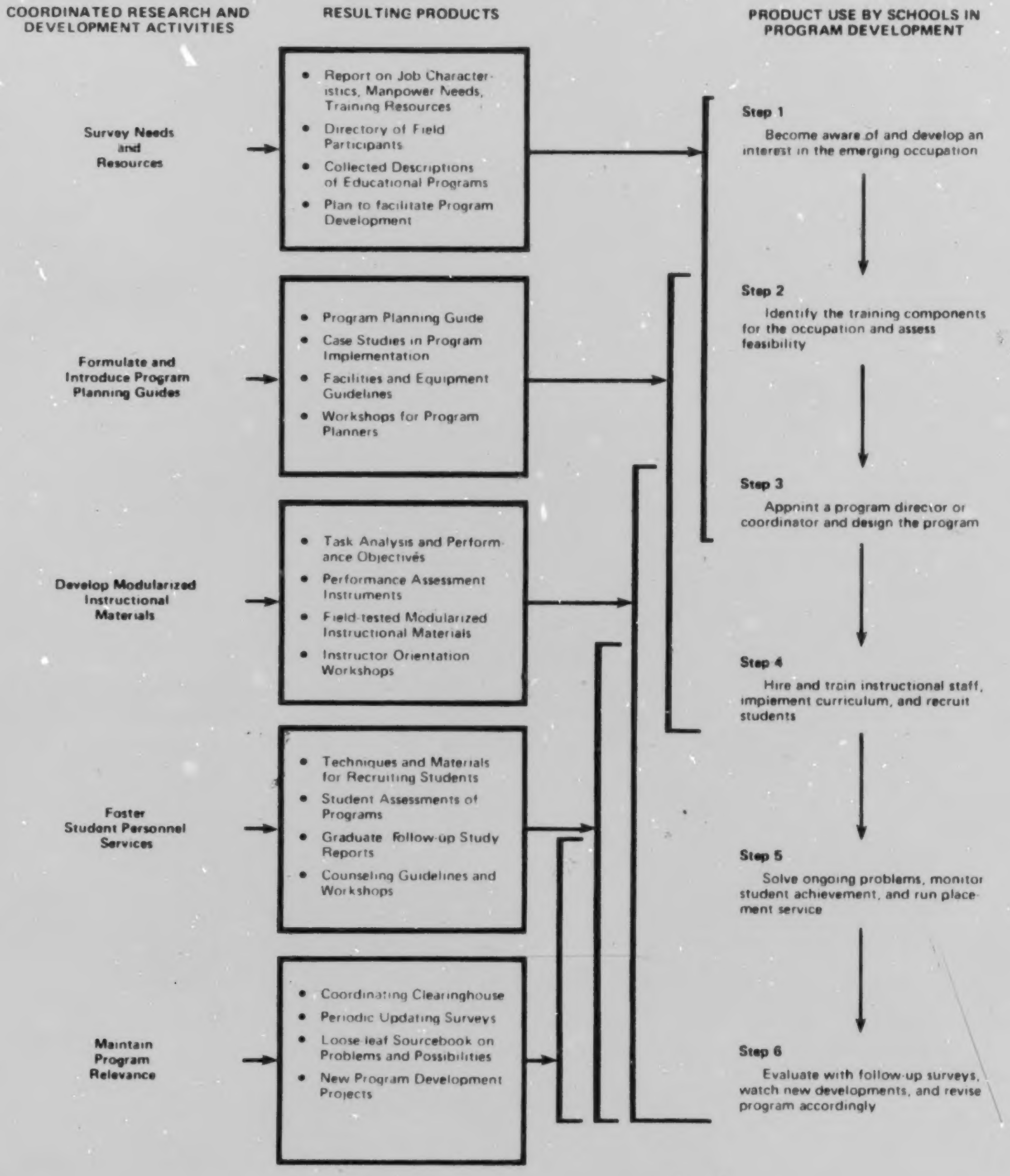
Projects to develop health related educational programs must take special account of the accreditation programs by the AMA Council on Medical Education. At the time the NMT project began there was no consensus in the field as to the appropriate curriculum for an NMT program. The NMT project recognized from its inception that achieving cooperation in the NMT field was vital to widespread implementation of NMT programs. Accordingly the NMT project staff worked closely on curriculum development over a period of four years with an Advisory Committee including members from the AMA Joint Review Committee on Nuclear Medicine Technology, representatives of the six professional societies, and representatives from the leading NMT programs.

As a result of this extended collaboration the NMT project in 1974 completed development of a detailed NMT Curriculum which is acceptable to all six NMT professional societies and meets the requirements of the American Medical Association for an accredited associate degree program in nuclear medicine technology. This model NMT curriculum is published in the NMT Curriculum Guide and constitutes a major project accomplishment.

The overall strategy of the project was to carry out those research and development activities planned in consultation with interested schools which would most effectively assist schools and collaborating hospitals to go through the six typical steps leading to the implementation of NMT programs. The types of coordinated research and development activities, typical resulting products, and product use by schools are outlined in general form in Figure 1.

FIGURE 1

Overall Strategy of a National Program Development Project to Facilitate Implementation of Educational Programs in New and Emerging Occupational Fields


COORDINATED RESEARCH AND DEVELOPMENT ACTIVITIES
RESULTING PRODUCTS
PRODUCT USE BY SCHOOLS IN PROGRAM DEVELOPMENT
Survey Needs and Resources
• Report on Job Characteristics, Manpower Needs, Training Resources
• Directory of Field Participants
• Collected Descriptions of Educational Programs
• Plan to facilitate Program Development
Formulate and Introduce Program Planning Guides
• Program Planning Guide
• Case Studies in Program Implementation
• Facilities and Equipment Guidelines
• Workshops for Program Planners
Develop Modularized Instructional Materials
• Task Analysis and Performance Objectives
• Performance Assessment Instruments
• Field-tested Modularized Instructional Materials
• Instructor Orientation Workshops
Foster Student Personnel Services
• Techniques and Materials for Recruiting Students
• Student Assessments of Programs
• Graduate Follow-up Study Reports
• Counseling Guidelines and Workshops
Maintain Program Relevance
• Coordinating Clearinghouse
• Periodic Updating Surveys
• Loose-leaf Sourcebook on Problems and Possibilities
• New Program Development Projects
Step 1
Become aware of and develop an interest in the emerging occupation
Step 2
Identify the training components for the occupation and assess feasibility
Step 3
Appoint a program director or coordinator and design the program
Step 4
Hire and train instructional staff, implement curriculum, and recruit students
Step 5
Solve ongoing problems, monitor student achievement, and run placement service
Step 6
Evaluate with follow-up surveys, watch new developments, and revise program accordingly

During the period 1968-74 the NMT project has worked cooperatively with all community colleges, technical institutes and other institutions known to be interested in NMT education. Most of the associate degree NMT programs now operating in the United States have been established with the involvement of the NMT project. Many additional schools are currently planning NMT educational programs utilizing NMT project materials and services. The project has resulted in a broad body of tested program planning and curriculum materials, which are now available for use by schools desiring to establish NMT programs.

In addition to catalyzing the development of new programs for nuclear medicine technology the NMT project has tested new procedures and products for coordinated program development which are applicable throughout technical education and also in other kinds of education. In particular the NMT project has pioneered techniques of involving local innovators throughout the country in the development and dissemination process through the NMT Interactive Network.

The NMT project explored the feasibility of combined educational programs for NMTs and for nuclear technicians (NTs). Nuclear technicians are primarily employed in nuclear power generation and other nuclear applications in industry. Although some commonalities exist it was found that these related fields are sufficiently different as to require quite different curricula. A separate project for the development and evaluation of postsecondary programs in nuclear technology was undertaken by TERC in 1974.

A major thrust of the NMT project since its inception has been to develop techniques to facilitate implementation of NMT programs throughout the country. During the last two years, the project staff have conducted extensive experimentation to determine the most effective strategies and techniques for disseminating and implementing NMT programs.

Figure 2 shows highlights of the NMT project from its inception through its completion in December, 1974. This figure shows for each year the major project activities, Federal project funds expended, the number of operating NMT associate degree programs in schools, and the approximate funding of these programs from state and local sources. Figure 3 shows the yearly geographical growth of NMT programs in schools throughout the country.

A measure of the effectiveness of the NMT dissemination and implementation strategies can be seen from Figure 2 by comparing the annual NMT Project Funds (Federal) with rapidly increasing annual State and local investment in NMT programs stimulated by the NMT Project.

FIGURE 2

HIGHLIGHTS OF NMT PROJECT

Development of Career Opportunities for
Nuclear Medical Technicians

Major Project Activities

NMT Project Begins
National Survey-Job Characteristics,
Manpower Needs, Training Resources

Survey Report Disseminated
Interactive Network Initiated
First National Project Evaluation

Compendium of Educational Programs
Disseminated
Case Study-Denver Community College
Interactive Network Conferences Held
Sourcebook Compiled and Disseminated
Second National Project Evaluation

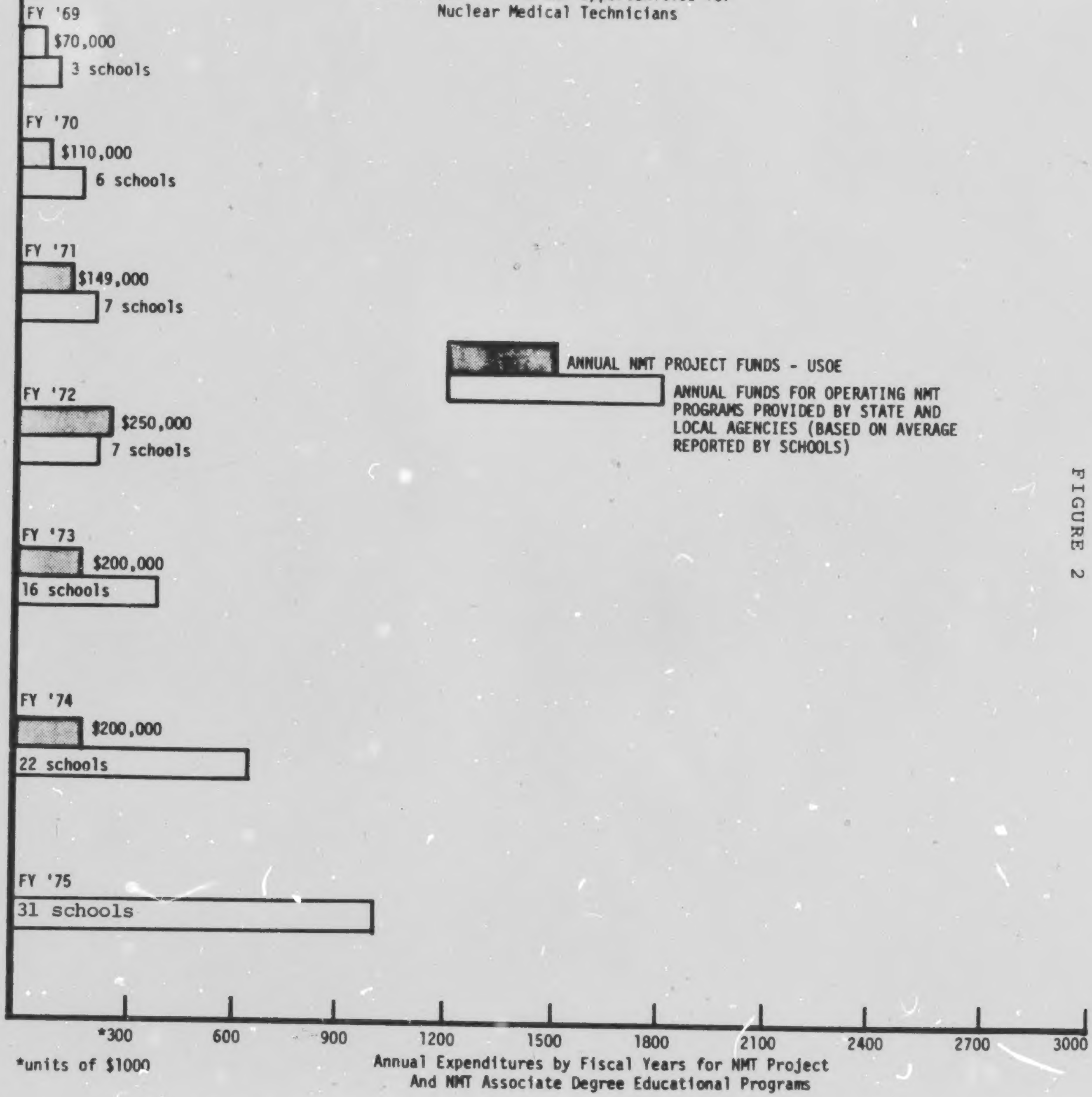
Curriculum Guide Outlined
Task Related Instructional Units
Drafted
Program Planning Guide Drafted
Recruitment Materials Developed
Career Lad[illegible] Report Drafted

Curricul[illegible] [illegible]e Drafted
Audio V[illegible] Units Developed
Digest [illegible] Educational Programs
Planning Workshops Held
Community College Needs Survey

Curriculum Guide Printed
Program Implementation Workshops Held
Planning Conferences Held
Product Dissemination Activities
Final Project Report

After Termination of USOE Funding

Projected Operation and Continued
Expansion of NMT Educational
Programs in Schools

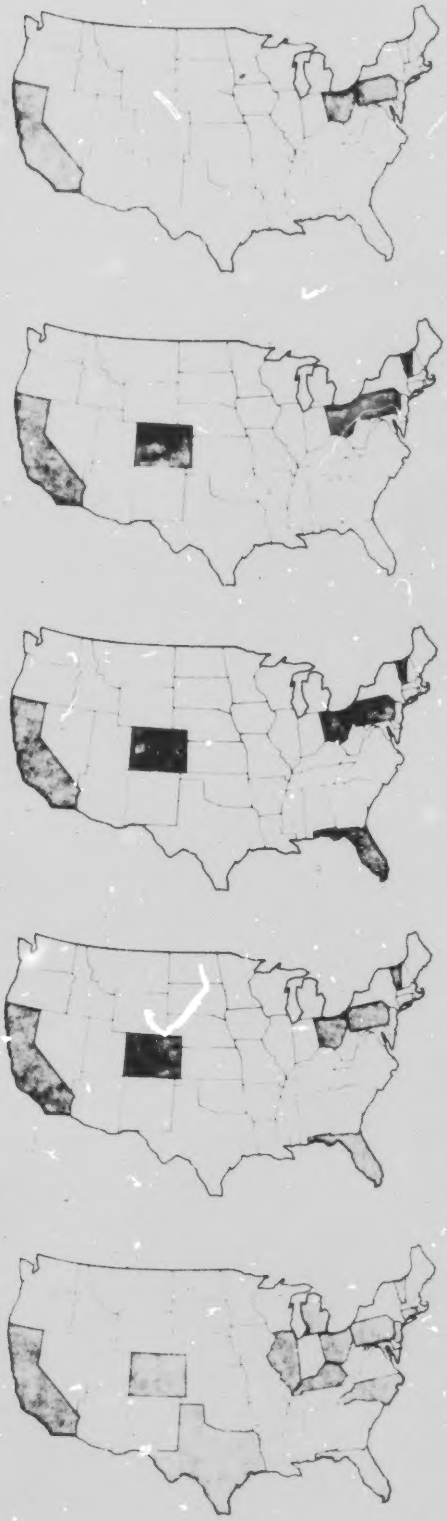


*units of $1000

Annual Expenditures by Fiscal Years for NMT Project
And NMT Associate Degree Educational Programs

FIGURE 3

GROWTH OF SCHOOL PROGRAMS
TERC NUCLEAR MEDICINE TECHNOLOGY PROJECT



YEAR	STATES	SCHOOLS INVOLVED
1969	3	3
1970	5	6
1971	6	7
1972	6	7
1973	14	16
1974	18	22
1975	20	31

TERC Technical Education Research Centers
44 Brattle Street, Cambridge, Mass. 02138

As this figure indicates the NMT project funds served as "seed money" to stimulate major state and local investments in NMT education and as such proved to be a highly cost effective use of Federal funds.

The NMT project has helped to establish a sound base for NMT education in the United States and has assisted the implementation of more than thirty NMT programs. This is an excellent beginning but does not yet fully meet the needs of this rapidly expanding field. Although the intensive program development phase has now been completed there is a continuing need for systematic NMT dissemination/implementation activities.

To meet this need it is recommended that an NMT dissemination/implementation project should be established and carried on at a relatively low level of funding for a period of three years. This might be done as a part of a broader dissemination/implementation of other programs developed under USOE sponsorship.

As of January, 1975 each of the four national program development projects in new and emerging technologies has been completed. Each project has clearly succeeded in establishing a sound basis for educational planning in its field and has catalyzed the implementation of many needed programs in its field and the planning of many more.

Taken together these four projects represent by far the largest and most comprehensive effort ever undertaken to find effective methods of solving the critical national problem of developing educational programs in new and emerging occupations.

Much has been learned from these projects which is of importance beyond the particular fields covered. The projects have demonstrated that even in our decentralized and pluralistic educational system it is possible to carry out national program development activities in such a way as to effectively catalyze the implementation of needed educational programs in diverse new occupational fields. Together these projects have produced a generalizable body of experience, strategies, and techniques which can form the basis of an ongoing national program for keeping our educational systems abreast of the constantly changing needs of new and emerging occupational fields. Such a national program is both needed and feasible.

Based on the experience gained over a seven year period from all four projects it is recommended that the development of a systematic national program for new and emerging careers be undertaken.

INTRODUCTION

Background

Even before World War II, the properties of radioactivity had been explored by scientists and physicians to provide better health care. Atomic research and nuclear developments brought significant advances in nuclear science. One of the results of these explorations in nuclear sciences is nuclear medicine technology.

Nuclear medicine procedures are an outgrowth of techniques developed in hospital radiology, pathology, and internal medicine departments. They are used for both diagnostic and therapeutic purposes. As a diagnostic technique, nuclear medicine technology provides information on organ structure and function that cannot be obtained from radiologic procedures alone. Physicians can examine human organs and observe human metabolism, digestion, and blood flow with increasing precision. While nuclear medicine is most widely used for diagnostic purposes, it has also been found to be highly effective in the treatment of certain types of diseases. For example, thyroid cancer has been successfully treated because therapeutic quantities of a radioactive substance can be concentrated in the thyroid without causing excessive radiation to other tissues.

Nuclear medicine procedures are based on the facts that radioactive drugs can be administered harmlessly to patients, that they localize in a particular organ, and that they therefore enable the organ to be imaged. The radioactive drugs, called radiopharmaceuticals, may be administered by injection, orally, or by inhalation. Depending upon the type of radiopharmaceutical and the method used for administering it, the drug is "taken up" by a particular organ. Sophisticated instrumentation traces where and how the radiopharmaceutical is concentrated in the patient's body.

The use of nuclear medicine procedures has become increasingly widespread and important. In fact, access to nuclear medicine services is now a requirement for hospital accreditation by the American Hospital Association's Joint Commission on Accreditation of Hospitals.

This requirement alone has ensured the expansion of nuclear medicine facilities and a corresponding need for more nuclear medicine technicians. Hospitals in the 100- to 300-bed range are now establishing their own nuclear medicine facilities. Each of these hospitals will need to employ one or two technicians. Furthermore, existing facilities are being expanded, and they are requiring additional support personnel.

These nuclear medicine technicians (NMTs) are needed to assist nuclear medicine physicians by performing a variety of clinical duties involved with nuclear medicine procedures. They prepare and measure the radiopharmaceutical doses for administration to patients and operate specially designed equipment. Furthermore, they are responsible for radiation safety procedures and for maintaining a variety of records NMTs must also interact with patients. Often they administer the radiopharmaceuticals. NMTs also explain the procedures to the patients, and perform the nuclear medicine tests.

Until a few years ago, technologists in radiology, internal medicine, and pathology departments were trained on the job as they were needed to assist in nuclear medicine procedures. The majority of nuclear medicine technicians or technologists (NMTs) came from radiology departments. The radiologic technologists' knowledge and skill in the areas of radiation safety, manipulation of controls, and patient positioning for imaging enabled them to be trained on the job with little difficulty.

As the need for NMTs grew and their preparation became more comprehensive and complex, on-the-job training grew increasingly less satisfactory. Informal instructional programs varied both in scope and depth. Furthermore many hospitals were not prepared to devote money and time to training programs for NMTs. This created a serious national problem which, if not corrected, would inhibit the growth and development of nuclear medicine.

Initiation of the NMT Project

In 1966 Technical Education Research Centers (TERC) was approached by the Society of Nuclear Medicine and others in the nuclear medicine field to discuss the serious national lack of personnel trained to assist nuclear medicine physicians. As a result of insufficient numbers of assistants, some nuclear medicine physicians found themselves spending up to ninety percent of their time performing procedures which could have been performed by nuclear medicine technicians or technologists (NMTs). It should be noted here that in the field NMTs are referred to as "technologists," perhaps as often as they are called "technicians." For the sake of consistency, NMTs are referred to in this report as "technicians" indicating persons who are specialized technological assistants prepared in two-year postsecondary programs.

The major cause of the problem had much in common with other new and emerging technologies, namely, the limited availability and quality of educational programs for preparing technical assistants. Nuclear medicine technicians at that time were almost entirely trained in hospitals which were typically prepared to deal with no more than three students at a time. Virtually no NMT programs existed in community colleges, technical institutes or other primarily educational institutions.

At that time there were no comprehensive curricula and few program planning materials for establishing NMT programs. In fact there was a great deal of confusion and misconception as to exactly what NMTs were and what they might be expected to do. For the most part, NMTs were prepared in informal programs by physicians or other NMTs usually to meet the specific needs of an individual hospital. Therefore, their training varied considerably according to the size and location of the hospital. Basic comprehensive training was rarely available because almost all NMTs were previously medical technologists, X-ray technologists, or nurses. This meant that few people without previous allied health training could become an NMT.

With the assistance of key nuclear medicine practitioners TERC carried out a preliminary survey of the needs for the development of new educational programs in the emerging occupational field of nuclear medicine technology. This survey indicated that in 1966 there were only approximately 2,000 NMTs in the United States. The rapid growth rate of the field indicated a need for 6,000 NMTs by 1970 and 12,000 by 1975. In view of the rapid continuing growth of the nuclear medicine field there was a current need to train at least 1,300 per year, a number far in excess of the capacity of the existing hospital programs. This was particularly true since many hospital educational programs were being reduced or eliminated because of hospital financial problems.

Unlike many other emerging areas, however, the nuclear medicine technology field possessed three crucial components for improving and planning the education of NMTs as well as for defining the tasks of NMTs. First, potential employers, that is, nuclear medicine physicians, were all too aware of the need for NMTs. They were therefore anxious to cooperate with efforts to increase and improve the education of their assistants. Second, hospitals were already providing educational programs for NMTs. Although these programs varied in depth, they were limited in their capacity to train numbers of NMTs, and were highly costly for the hospitals, they provided the initial steps for the improvement and further development of NMT education. They also provided for a group of potential educators in the field. Third, there were in existence several professional societies that were concerned about standardizing the education of NMTs, monitoring their certification, and defining their place in the world of allied health professionals. These concerned professional societies included: American College of Radiology; American Society of Clinical Pathologists; Society of Nuclear Medicine Technologists; American Society of Radiologic Technologists; American Society of Medical Technologists; and Society of Nuclear Medicine.

Based on its preliminary study TERC concluded that there was a serious and growing national imbalance between the increasing needs for nuclear medicine technicians and the lack of available or foreseeable NMT educational programs. It appeared that the most feasible way to correct this imbalance would be to develop associate degree level NMT programs in community/junior colleges, technical institutes, and universities in close collaboration with nearby hospitals. Fifty or more such programs were needed to meet the needs of the field. Development of these collaborative associate degree programs would bring the education of nuclear medicine technicians (like that of many other health related technicians) into the educational mainstream and provide college level credit to NMT program graduates.

Inasmuch as no experience existed for such collaborative college/hospital NMT programs within the United States, the NMT project was initiated by TERC with the support and cooperation of the NMT professional societies as a nationally coordinated program development project with the sponsorship of the U. S. Office of Education. The goal of the project was to increase career opportunities in nuclear medicine technology by assisting the field to develop comprehensive NMT educational programs based on cooperation between schools and hospitals. The cooperative effort would enable the preparation of greater numbers of NMTs, and would relieve hospitals of much of the responsibility for didactic coursework and of the costs for preparing an NMT. Comprehensive programs would enable high school graduates to enter NMT field without previous allied health training. The "theft" of technical assistants prepared for other medical technologies would also be reduced.

Project Approach

In facilitating the development of needed NMT educational programs the NMT project played a threefold role as (1) catalyst and coordinator, (2) researcher and developer, and (3) disseminator/implementor. As catalyst and coordinator the project brought together members of existing interest groups in the field within an "interactive network." These groups consisted of employers (physicians), educators (in hospitals and schools), students (both those from other allied health fields and high school graduates), professional societies (who help define and regulate the new technology), and educational publishers (who may have published materials for NMTs, or may be potential publishers of materials). In its role as researcher and developer the project systematically gathered information necessary to determine the needs of the field and to develop program planning and curriculum materials. As disseminator/implementor the NMT project disseminated information and educational materials to the field as they were prepared so that their usefulness could be evaluated by the users and so that the materials would be available to the field for immediate use. The project also actively assisted schools to implement new programs.

The project's philosophy of examining all aspects of the field concerned with NMT education demanded that the viewpoints of as many different groups and individuals as possible be included in the assessment of the situation, problem identification, and problem solution activities. From the outset of the project, every effort has been made to be responsive to the needs of various groups involved with NMT education and to provide opportunities for the field's experts to participate actively with TERC and with each other through surveys, formal workshops, as consultants, by reviewing and evaluating project materials, and through the NMT Interactive Network, a communications mechanism developed by TERC at the outset of the project.

In order to reach the goal of advancing career opportunities in nuclear medicine technology, the NMT project set about determining the range of issues related to NMT education and employment, and identifying those which were most pressing or problematic. Having done this the project planned to assist the field in recognizing and solving those issues with the end result of more systematic and effective educational NMT programs. These programs, in turn, would benefit the field as a whole.

In undertaking this project TERC had to keep in mind at all times that the field was changing rapidly and that an activity that was relevant yesterday might not be tomorrow. For example, it was originally anticipated that the main thrust of the project would be towards the development of a curriculum outline which would be pilot-tested in one or more groups of cooperating schools and hospitals; to make revisions as needed; and then to transplant this program to other schools. As the project developed it became clear that this plan would not fully meet the needs of the field of nuclear medicine technology. First, unlike other emerging areas, nuclear medicine technology had from its inception many of the structures which defined it as a separate, identifiable specialty; second, there were hospital-based nuclear medicine programs already established; and third, the AMA Council on Medical Education was already in the process of determining in a general way, what an adequate NMT program would look like. Obviously the field did not simply need a new curriculum to be handed down from an educational research project.

There was, however, a great deal of information that educators in the field of nuclear medicine needed and wanted to know; for instance, how had other NMT educational programs been established? What problems were encountered? How were the problems solved? What might the solutions be to unsolved problems? Answers to questions such as these and other questions that arose as the project proceeded caused the activities of the project to extend far beyond the development of a curriculum outline.

Objectives

The overall objective of the NMT project was to catalyze the development of needed NMT educational programs throughout the country. The overall strategy of the project was to carry out those research/development and dissemination activities which would most effectively assist schools in implementing new NMT programs. This required the establishment of four specific project objectives:

1. To define the parameters of the NMT field and its needs.
2. To collect and evaluate information useful in implementing NMT programs.
3. To synthesize the results of the collected and evaluated information into program planning materials and other products.
4. To disseminate NMT products to the field and facilitate NMT program implementation.

A brief summary of the project activities related to each of these four objectives is outlined below:

Defining the Parameters of the Field and its Needs

In 1969, TERC conducted a national survey of NMT job characteristics, manpower needs, and training requirements and resources. The survey was designed to:

1. Provide an estimate for the number of NMTs employed in 1969, the number needed at that time, and the number likely to be needed by 1975;
2. Identify the performance objectives of an NMT and from them, to derive job descriptions for the NMT;
3. Discover the nature and extent of existing preparatory programs especially in two-year, technical institutes, divisions of four-year institutions;
4. Explore the feasibility of NMT preparatory programs involving cooperation among hospitals and educational institutions; and
5. Consider what new instructional materials or new programs if any, would be required to meet employment needs.

By using a survey to gain this information, initial communication with the field was established, and the points of view of the different groups and individuals involved were gathered. The results of this survey (Interim Report Number 1, Survey of

Job Characteristics, Manpower Needs, and Training Resources, July, 1969) were disseminated to the field, further increasing the extent and participation of experts and interested parties.

Collecting and Evaluating Information

Through the survey it was found that, despite the newness of the field, a fairly large number of NMT training programs existed. Most were small, informal, and hospital based, producing only one or two NMTs every few years. A few, however, were more formal, had developed course outlines, and were school-hospital cooperative efforts granting degrees. The survey further indicated that many hospitals were anxious to work with schools to develop formal NMT programs but did not know exactly how to proceed.

The information obtained from this survey was the basis for determining what sort of information should be collected and evaluated in meeting the second objective. Types of needed information identified through the survey included:

1. A detailed NMT task list,
2. Information on clinical training,
3. Effect of emerging areas in nuclear medicine on NMT education,
4. Criteria for evaluating student performance,
5. Information on student recruitment,
6. Information on career ladders,
7. Program planning information for initiating new school and hospital programs and curriculum development, and
8. Information on available and needed instructional materials.

The variety of needed information indicated to TERC that the original plan of simply developing curriculum outlines would not suffice to meet the needs of the field. To collect and evaluate relevant information, TERC engaged in several activities in conjunction with representatives of the field who had indicated an interest through the national survey. These activities included conducting case studies of existing programs; identifying all existing NMT programs, and conducting a series of workshops. The results of these efforts were disseminated to the field through reports of the case studies, the Compendium of NMT Programs, and A Sourcebook of Working Papers on Problems and Possibilities.

Although these documents provided the field with valuable information, not all of the activities had such obviously visible results. Many of the benefits derived from these activities had to do with process and communications between groups and individuals. A forum had been provided, particularly through the workshops, which resulted in communications links that were previously nonexistent. Sharing of information and problems occurred, which helped to turn a rather nebulous field into a more effective and cohesive group that would be capable of pursuing its own interests after the NMT project was completed.

Synthesizing the Results of the Collected and Evaluated Information

All of the problem areas identified in the original national survey were researched and discussed as a part of the NMT project. However, in many cases more questions were asked than answered. During this time planned activities were changed. Some had not borne the fruit that had been expected of them; some resulted in unexpected ends that influenced the pursuance of other activities. The tentative results and the discussions concerning these various areas have been included in the Sourcebook of Working Papers. This document had, in fact been designed with the aim of encouraging evaluation and criticism from the field of the accuracy and relevance of TERC's efforts.

Eventually, however, conclusions had to be drawn. TERC had to make decisions as to what had, in fact, been learned, what was of particular value to the field, and what materials TERC would develop to assist in implementing new NMT programs. Materials were developed to fill several specific needs:

1. Administrator's and Instructor's guides

   Nuclear Medicine Technology: A Suggested Postsecondary Curriculum

   The Collected Case Studies of NMT Programs

2. Instructional Materials

   Visual Task Descriptions-The Liver Scan Series

   Slide/Tape Materials-The Brain Scan Examination Procedures

3. Student Recruitment Materials

   TERC NMT Recruitment Brochure

4. Field Communications

   Digest of Educational Programs: Nuclear Medicine Technology

Disseminating Products and Facilitating Program Implementation

Dissemination in a project such as this serves several purposes: it leads to the end result of such a project--namely, some form of useful change--and useful change is dependent upon a continuous dialectic with the field.

Exchanges with the field are necessary to:

1. Determine what improvements are wanted,

2. Implement and achieve improvements, and

3. Evaluate results.

At all stages the project disseminated its reports to the field for evaluation and criticism. These comments from the field were acted upon to ensure that TERC's research efforts were relevant and accurate. The value of the materials TERC developed was then demonstrated by the effect they had on the field.

The process of dissemination was conducted through the various groups and individuals who had responded to the surveys, had requested information, had ordered NMT project products, and had in other ways expressed interest in the development of the project. Close track was kept at all times of the needs of these individuals and systematic efforts were made to keep in touch with them. Henceforth, they are referred to as the "interactive network." Further dissemination effort was made during the last year of the project by contacting community college and technical institutes to determine whether additional materials are required other than those already available for establishment of NMT programs.

Institutional Involvement in Development of NMT Project Products

A unique feature of the NMT project has been the extensive involvement throughout of a wide range of individuals and institutions in the development and testing of the NMT project products. A list of the more than 460 universities, schools, hospitals, businesses and others involved in the development of the NMT project products is shown in the appendix. A second list of the more than 240 universities, schools, hospitals, and others involved in the testing of NMT products is also shown in the appendix.

PROGRAM PLANNING MATERIALS AND SERVICES

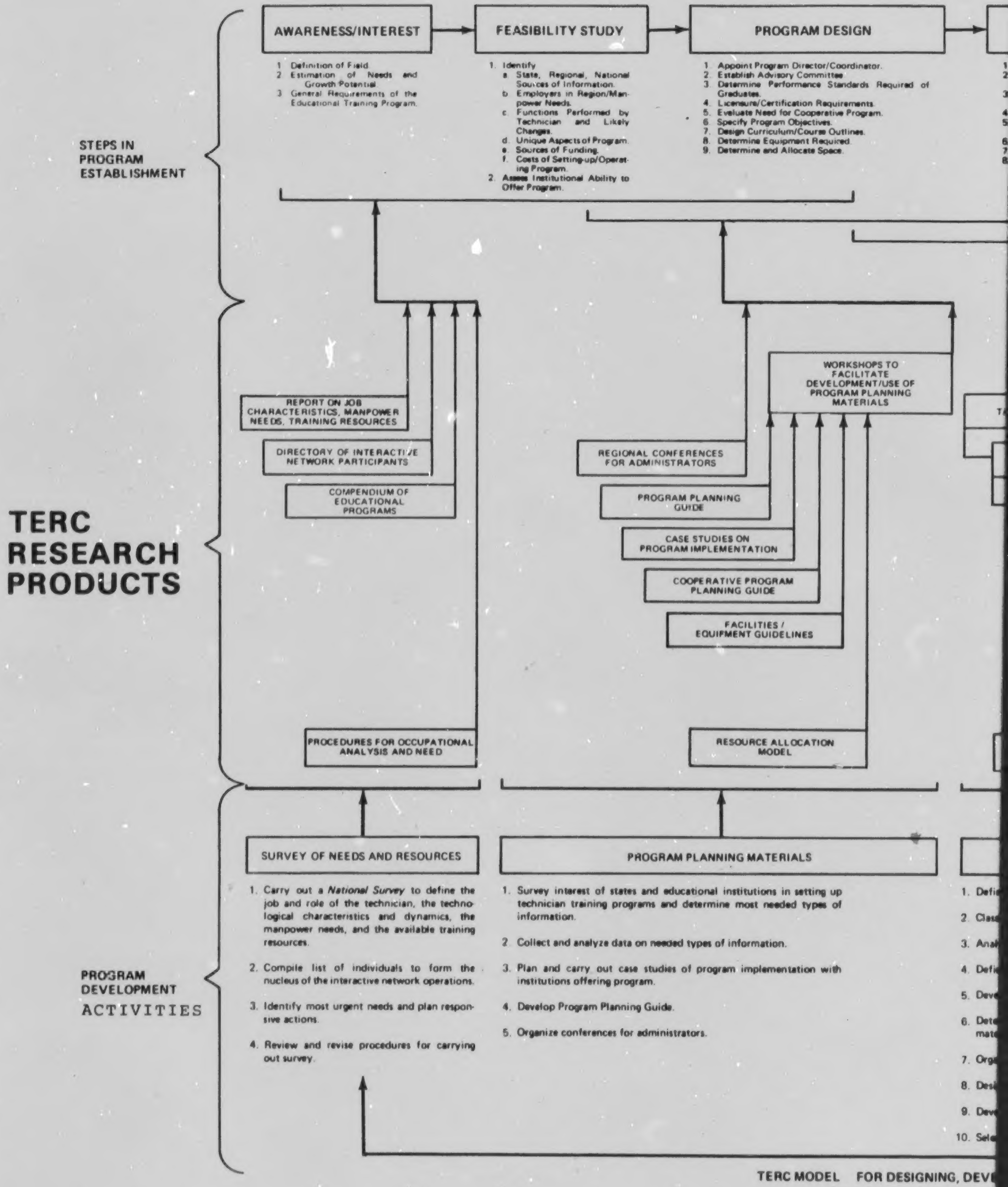
A major activity of the project from its inception was to develop and disseminate a variety of needed materials and services designed to assist administrators and teachers in planning and implementing NMT programs. School administrators considering establishing a new educational program need accurate information about the structure of the occupational field, the knowledge and skill required of technicians in the field, and the characteristics of educational programs needed to prepare these technicians. After a decision has been made to establish a new program; deans of instruction, department heads, and teachers need additional detailed program planning materials. In an emerging technology such as nuclear medicine technology, this information is typically not available to program developers in any systematic form, and this lack of information seriously inhibits the implementation of new programs. The development and dissemination of program planning materials was particularly essential in the NMT field since few schools had experience with implementation of collaborative programs between schools and nearby hospitals.

As a first step in defining what program planning and other materials and services were needed, a general model for designing, developing, and establishing new educational programs was conceptualized. This model is shown in Figure 4. The steps that an educational institution must take to establish a new program are shown horizontally across the top of the model. These include awareness/interest, feasibility study, program design, program start-up, ongoing program operation, and ongoing evaluation and revision.

A program development project such as the NMT project can assist schools to establish new programs by developing and disseminating products and services which are keyed to these five steps. Some of these types of products and services are shown as "TERC Research Products" across the middle of Figure 4. They result from a series of project activities shown along the bottom of the model. The five categories of project activities are: Surveys of Needs and Resources; Program Planning Materials; Instructional System Development; Student Personnel Services; and Maintenance of Program Relevance. This conceptual model was adopted by the NMT project in 1970 and was used to identify and describe project activities and products. Figure 1 in the Summary section is a somewhat simplified version of Figure 4.

The priorities for developing specific materials and the order in which they were developed were determined in consultation with the NMT field through the NMT Interactive Network. A similar strategy was followed in planning the BMET project. This section describes a number of specific project activities including employer surveys, case studies, workshops, and conferences and the program planning materials which were developed as a result of these activities.

FIGURE 4


STEPS IN PROGRAM ESTABLISHMENT
AWARENESS/INTEREST
FEASIBILITY STUDY
PROGRAM DESIGN
TERC RESEARCH PRODUCTS
REPORT ON JOB CHARACTERISTICS, MANPOWER NEEDS, TRAINING RESOURCES
DIRECTORY OF INTERACTIVE NETWORK PARTICIPANTS
COMPENDIUM OF EDUCATIONAL PROGRAMS
PROCEDURES FOR OCCUPATIONAL ANALYSIS AND NEED
WORKSHOPS TO FACILITATE DEVELOPMENT/USE OF PROGRAM PLANNING MATERIALS
REGIONAL CONFERENCES FOR ADMINISTRATORS
PROGRAM PLANNING GUIDE
CASE STUDIES ON PROGRAM IMPLEMENTATION
COOPERATIVE PROGRAM PLANNING GUIDE
FACILITIES / EQUIPMENT GUIDELINES
RESOURCE ALLOCATION MODEL
PROGRAM DEVELOPMENT ACTIVITIES
SURVEY OF NEEDS AND RESOURCES
PROGRAM PLANNING MATERIALS

AWARENESS/INTEREST

1. Definition of Field.
2. Estimation of Needs and Growth Potential.
3. General Requirements of the Educational Training Program.

FEASIBILITY STUDY

1. Identify
   a. State, Regional, National Sources of Information.
   b. Employers in Region/Manpower Needs.
   c. Functions Performed by Technician and Likely Changes.
   d. Unique Aspects of Program.
   e. Sources of Funding.
   f. Costs of Setting-up/Operating Program.
2. Assess Institutional Ability to Offer Program.

PROGRAM DESIGN

1. Appoint Program Director/Coordinator.
2. Establish Advisory Committee.
3. Determine Performance Standards Required of Graduates.
4. Licensure/Certification Requirements.
5. Evaluate Need for Cooperative Program.
6. Specify Program Objectives.
7. Design Curriculum/Course Outlines.
8. Determine Equipment Required.
9. Determine and Allocate Space.

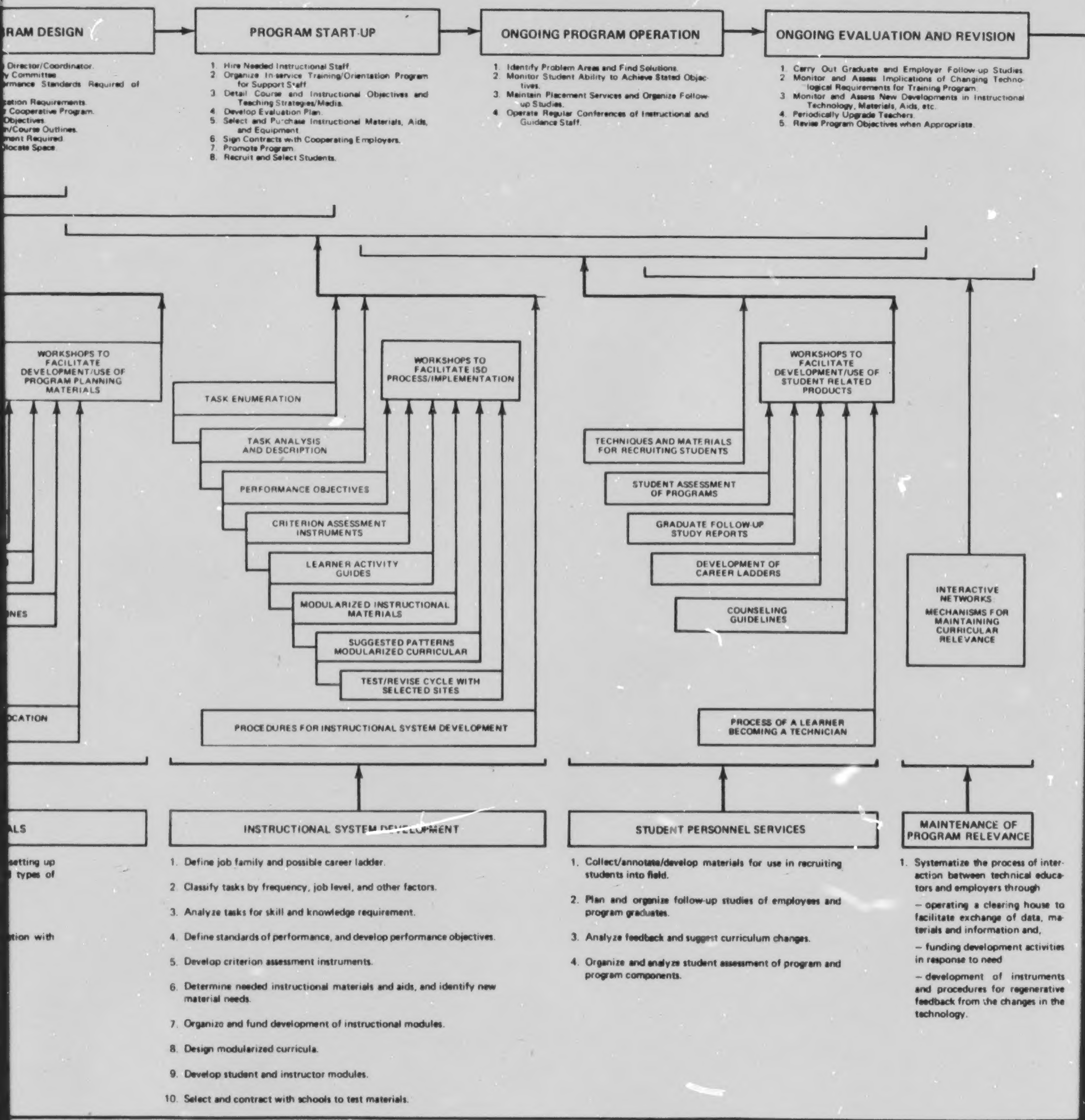
SURVEY OF NEEDS AND RESOURCES

1. Carry out a *National Survey* to define the job and role of the technician, the technological characteristics and dynamics, the manpower needs, and the available training resources.
2. Compile list of individuals to form the nucleus of the interactive network operations.
3. Identify most urgent needs and plan responsive actions.
4. Review and revise procedures for carrying out survey.

PROGRAM PLANNING MATERIALS

1. Survey interest of states and educational institutions in setting up technician training programs and determine most needed types of information.
2. Collect and analyze data on needed types of information.
3. Plan and carry out case studies of program implementation with institutions offering program.
4. Develop Program Planning Guide.
5. Organize conferences for administrators.

TERC MODEL FOR DESIGNING, DEV



RAM DESIGN
PROGRAM START-UP
ONGOING PROGRAM OPERATION
ONGOING EVALUATION AND REVISION
WORKSHOPS TO FACILITATE DEVELOPMENT/USE OF PROGRAM PLANNING MATERIALS
INES
OCATION
TASK ENUMERATION
TASK ANALYSIS AND DESCRIPTION
PERFORMANCE OBJECTIVES
CRITERION ASSESSMENT INSTRUMENTS
LEARNER ACTIVITY GUIDES
MODULARIZED INSTRUCTIONAL MATERIALS
SUGGESTED PATTERNS MODULARIZED CURRICULAR
TEST/REVISE CYCLE WITH SELECTED SITES
WORKSHOPS TO FACILITATE ISD PROCESS/IMPLEMENTATION
PROCEDURES FOR INSTRUCTIONAL SYSTEM DEVELOPMENT
TECHNIQUES AND MATERIALS FOR RECRUITING STUDENTS
STUDENT ASSESSMENT OF PROGRAMS
GRADUATE FOLLOW-UP STUDY REPORTS
DEVELOPMENT OF CAREER LADDERS
COUNSELING GUIDELINES
WORKSHOPS TO FACILITATE DEVELOPMENT/USE OF STUDENT RELATED PRODUCTS
PROCESS OF A LEARNER BECOMING A TECHNICIAN
INTERACTIVE NETWORKS
MECHANISMS FOR MAINTAINING CURRICULAR RELEVANCE
ALS
INSTRUCTIONAL SYSTEM DEVELOPMENT
STUDENT PERSONNEL SERVICES
MAINTENANCE OF PROGRAM RELEVANCE

RAM DESIGN

Director/Coordinator.
y Committee
rmance Standards Required of

cation Requirements.
Cooperative Program.
Objectives.
n/Course Outlines.
ment Required
locate Space

PROGRAM START-UP

1. Hire Needed Instructional Staff.
2. Organize In-service Training/Orientation Program for Support Staff
3. Detail Course and Instructional Objectives and Teaching Strategies/Media.
4. Develop Evaluation Plan.
5. Select and Purchase Instructional Materials, Aids, and Equipment
6. Sign Contracts with Cooperating Employers.
7. Promote Program.
8. Recruit and Select Students.

ONGOING PROGRAM OPERATION

1. Identify Problem Areas and Find Solutions.
2. Monitor Student Ability to Achieve Stated Objectives.
3. Maintain Placement Services and Organize Follow-up Studies.
4. Operate Regular Conferences of Instructional and Guidance Staff.

ONGOING EVALUATION AND REVISION

1. Carry Out Graduate and Employer Follow-up Studies
2. Monitor and Assess Implications of Changing Technological Requirements for Training Program.
3. Monitor and Assess New Developments in Instructional Technology, Materials, Aids, etc.
4. Periodically Upgrade Teachers.
5. Revise Program Objectives when Appropriate.

ALS

setting up
types of

tion with

INSTRUCTIONAL SYSTEM DEVELOPMENT

1. Define job family and possible career ladder.
2. Classify tasks by frequency, job level, and other factors.
3. Analyze tasks for skill and knowledge requirement.
4. Define standards of performance, and develop performance objectives.
5. Develop criterion assessment instruments.
6. Determine needed instructional materials and aids, and identify new material needs.
7. Organize and fund development of instructional modules.
8. Design modularized curricula.
9. Develop student and instructor modules.
10. Select and contract with schools to test materials.

STUDENT PERSONNEL SERVICES

1. Collect/annotate/develop materials for use in recruiting students into field.
2. Plan and organize follow-up studies of employees and program graduates.
3. Analyze feedback and suggest curriculum changes.
4. Organize and analyze student assessment of program and program components.

MAINTENANCE OF PROGRAM RELEVANCE

1. Systematize the process of interaction between technical educators and employers through
   - operating a clearing house to facilitate exchange of data, materials and information and,
   - funding development activities in response to need
   - development of instruments and procedures for regenerative feedback from the changes in the technology.

MODEL FOR DESIGNING, DEVELOPING AND ESTABLISHING A NEW EDUCATIONAL PROGRAM

Technical Education Research Centers

Survey of Job Characteristics, Manpower Needs, and Training Resources (1969)

When the NMT project began in 1968 the field of nuclear medicine like most new and emerging occupational fields was rather fragmented. Approximately 200 hospitals throughout the United States had nuclear medicine facilities. The organizational patterns for nuclear medicine within these hospitals varied greatly with nuclear medicine variously being conducted in the departments of radiology, pathology, internal medicine, and in independent nuclear medicine departments. Nuclear medicine was being practiced by more than 5,000 physicians who were licensed by the Atomic Energy Commission or by states to administer radioisotopes. These licensed nuclear medicine practitioners supervised the approximately 3,000 NMTs. Six professional societies were concerned with the nuclear medicine field. There was a considerable difference of opinion within the field as to terminology, as to the tasks NMTs should perform, and as to the kind of preparation NMTs should have. The field was very active and was growing rapidly, but little systematic information was available as to its structure, its needs, and its training resources.

In view of these facts it was clear at the outset that the first task of the NMT project must be to conduct a systematic occupational analysis of the nuclear medicine field. This national survey, and the report that resulted from it, represents the NMT project's first effort to gain and disseminate a comprehensive view of nuclear medicine technology.

In developing the questionnaire instruments for the survey, TERC consulted many experts in the field. The survey was carried out by interviewing NMTs and their employers in hospitals in twenty-one major cities across the country and through mailed questionnaires to hospitals in other cities across the country. Approximately 350 hospitals employing NMTs participated in the survey (65% through the personal interviews and the remainder through the mailed questionnaire). A copy of the NMT Interview Schedule is contained in the appendix.

The report served to provide a range of factual and descriptive information about the NMT, what tasks he/she performs, what future needs will be, how and where NMTs are trained, and what a typical NMT curriculum looks like.

It had and continues to have immediate use to many in planning new programs, determining future needs, and acting as a dissemination medium for the AMA Committee's proposed "Essentials for Accrediting A School in Nuclear Medicine Technology" which is included in the report's appendix. Since its publication 700 copies have been distributed. In the survey, hospitals had expressed an interest in collaborating with schools in establishing NMT programs. It was therefore decided that program planning materials which included a description of the range of problems, would be appropriate as well as a curriculum outline.

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The activities which followed as a result of the survey were aimed at obtaining the information relevant to preparing these guides and at identifying other problem areas. The results of these activities were often useful within themselves and just as often uncovered other important needs.

CASE STUDIES OF EXISTING NMT PROGRAMS (1970-72)

The first step that the NMT project took towards developing a program planning guide was to explore those programs that already existed. It was decided to perform case studies of the history and development of those NMT programs which represented the range of formal structures. The programs studied varied in length from one to four years and their organizational structure included hospital-based, school-based, and collaborative programs. Between 1970 and 1972 TERC conducted case studies of ten programs all over the country. These studies were conducted to describe the programs, not to evaluate them.

The purpose of these case studies was:

1. To trace the history of each program within its environmental context;
2. To explore and describe all the facets or components of each program (staffing, funding, organizational structure, entrance requirements, recruitment methods, curriculum with didactic and clinical, graduation requirements, job placement, linkages with other institutions, and curriculum materials used);
3. To identify the range of problems each program encountered in its development and the solutions that were employed; and
4. To identify those problems related to the training of NMTs which are generic to the NMT field as a whole.

In 1970, TERC undertook the case study of the Denver Collaborative Training Program in Radiologic Technology. This program involved fourteen hospitals, a medical center, and a community college. Over eighty participants in the program including directors, teachers, students, clinical supervisors, and advisory board members were interviewed by TERC staff.

In 1972 another extensive case study was conducted at Hillsborough Community College in Tampa, Florida. This program was of particular interest because it had evolved in early 1969 from a very small hospital-based program at Tampa General Hospital into a sophisticated and expanding collaborative program. TERC staff interviewed ten staff members and eleven students in the Hillsborough Community College NMT program.

Areas of concern included funding, negotiations with participating institutions, scheduling, staffing, student recruitment, and services and curriculum evaluation and changes.

The case studies served several purposes: They were disseminated to the field as examples of how or how not to establish NMT programs; they provided information for use by TERC in the development of its program planning guide; and they confirmed previously identified problems and indicated problem areas that had not previously been defined.

As an example, one of the chief problems associated with NMT program development highlighted during the case study of the Denver Collaborative Program in Radiologic Technology and identified in case studies of other programs relates to the clinical aspects of NMT education. All operating NMT training programs involve considerable instruction in the clinical setting. But the clinical component of a program may create difficulties, particularly when it is not sufficiently integrated with the academic component.

For example, it may be left entirely up to the clinical instructor to determine what, how, and when to teach the student. All too often (1) the students get caught up in the diversity of the day to day operations of the department; (2) there is no attempt to define or rank the range of experiences the students should encounter in the clinical program; and (3) the individual responsible for clinical training is an NMT who typically never had the benefits of formal NMT education himself/herself. Because of the diversity of training in the field, problems such as this had no simple answer. The case studies unveiled several problems such as this one, which would be discussed at length at the NMT workshops.

Compendium and Digest of NMT Programs (1972, 1974)

In addition to preparing case studies of individual programs, TERC undertook the task of identifying all existing NMT programs. The Compendium was initially put in a looseleaf notebook to facilitate periodic revisions as new programs began and presently operating programs made changes in their status, size, or content.

This effort was prompted by indications both in the national survey and in the case studies that the NMT field was fragmented. There were very few channels for sharing information about what was going on in the field. Not only were NMT programs being established without the benefit of the experience of existing programs, but programs were being established without the knowledge of what other programs might already exist in the region. As long as individual hospitals were training one or two NMTs to work for them, this lack of awareness was not crucial; however, when the goal of a program was to prepare NMTs for the field at large, it became important to know how many NMTs were already being prepared in a given region and how many would be required. If a listing of all NMT programs were developed, the routes for sharing information could be opened, and eventually rational regional planning might take place. TERC undertook to make such a listing.

The objectives of this activity, then, were:

1. To discover which institutions were actually operating or planning to operate NMT programs; and

2. To determine the type or types of NMT program offered at each of these institutions.

Information collected for the compendium included the name and address of the program director, length of the program, degree or certificate granted, entrance requirements, number of graduates a year, cost, and status of certification. The programs identified were broken down into HEW region and by the type of program (baccalaureate degree programs, associate degree programs, one- and two-year hospital-based programs, nondegree-granting programs, and short courses). This document proved to be valuable for identifying appropriate programs for prospective NMTs, employers looking for prospective NMTs, and communications between individuals and groups interested in establishing new NMT programs.

In 1974 a revised versions of the compendium, called the Digest of NMT Educational Programs was prepared. Several points have taken on more importance since the field has become more tightly defined, and these points are reflected in the information included in the updated Digest.

A crucial question in the next few years will be whether or not an NMT program has been accredited by the American Medical Association, Council on Medical Education. Graduation from an accredited program is to become one of the requirements for eligibility to take the registry exam. Of interest in relation to registry examinations is the number of students in a class who have passed the registry exam.

Two questions covered were of particular interest: the number of students who can begin their NMT preparation with only a high school diploma as opposed to having previous paramedical training, and the number of hospital-based programs that have chosen to affiliate with or are planning to affiliate with educational institutions.

NMT Workshops on NMT Education

With each major activity, TERC discovered partial solutions to problem areas and identified new ones. The national survey indicated the interest of hospitals in collaboration with schools and began the development of a task list. The case studies provided initial information about planning collaborations and provided examples of existing curricula. The Compendium of NMT Educational Programs provided a vehicle for communication between NMT educators. Each of these activities also resulted in the need for deeper exploration into problem areas.

As the Denver Community College case study demonstrated, there were often no easy answers, partly because of the variety of education in the field. This led TERC to the conclusion that many of the problems could be best worked out through a series of national workshops on NMT education at which participating professionals, educators, and employers could discuss alternatives to a variety of problems. In choosing areas for discussion TERC avoided the political issues of the field, such as the existence of two separate registries and the individual concerns of the various organizations involved with nuclear medicine technology. Instead substantive issues were chosen: These included student recruitment; further refinement of the NMT task list; development of curriculum and instructional materials; the need for clinical instructor training; the effect of emerging areas in nuclear medicine on the education of NMTs; and career ladders.

The steps involved in planning and implementing the workshops were as follows:

1. Prior to the workshop, the NMT project staff explored the dimensions of the issue, collected necessary data, and defined the problem areas as concisely as possible. This information was sent to workshop participants in advance.

2. During the workshop a range of solutions to the problem area(s) was sought through discussion, exercises, review, and comments. Recommendations for further efforts were also made.

3. After the workshop the results and any additional data collected based on the workshop participants were written in a draft report. The draft report was sent to workshop participants and other experts for review and comment.

4. A report based on the review and comments was prepared and circulated through the Sourcebook on Working Papers.

First NMT Workshop, Cambridge, Massachusetts, December 10-11, 1970

In planning the first NMT workshop attended by nineteen key NMT professionals and educators, TERC reviewed what had been learned through the national survey, the case studies, and subsequent discussions with members of the field. Identified areas of concern are summarized in the following five questions:

1. What are the different jobs an NMT performs and are there different levels of employment that follow from them?
2. What are the specific tasks that an NMT performs?
3. What should be taught in a clinical setting and how should clinical instruction be structured? What can be taught in an academic setting?
4. Is it possible to identify critical incidents in NMTs' work that can be used for instruction?
5. What areas are emerging in nuclear medicine that will have future implications on NMT education?

In response to these questions, the following objectives were designed for the workshop:

1. To revise the NMT task list.
2. To sort the task list on the basis of the following criteria:
   a. frequency
   b. job level
   c. importance
   d. types of learning required to teach each task
   e. selecting the best teaching environment for each task (clinical or academic).
3. To identify emerging or changing areas in the practice of nuclear medicine.
4. To identify critical incidents to illustrate effective or ineffective performance on the part of the NMT.
5. To identify needs for and constraints to structuring the clinical aspects of the training of an NMT.
6. To identify the need for a clinical instructor's training program.

7. To recommend the structure and content of a clinical instructor's training program.

8. To identify teaching techniques and media that can be used in the clinical setting, and

9. To identify methods for evaluating students in the clinical setting.

A draft report of the workshop was reviewed by participants. Two problems were identified. The first concerned the definition of job levels and ranking of task by job level. TERC conducted a survey of the nuclear medicine department of the workshop participants, and the information was included in the final report. The second problem concerned emerging areas. Reports of consulting physicians about areas which might influence the education were included in the final report, which was disseminated through the Sourcebook of Working Papers.

Second NMT Workshop, Denver, Colorado, March 28-30, 1971

The issues identified for focus at the second workshop attended by twenty national leaders in the nuclear medicine field grew out of discussions and recommendations from the first workshop and other experiences TERC had with the field, such as visits to seven NMT programs. The differences among programs in terms of organizational structure, length, entrance requirements, structure of the clinical aspects of training, and goals led to the following objectives:

1. To examine the Clinical Instructor's Training Program developed by Dr. Miles Anderson at UCLA; evaluate the program; and determine how the program can be used by the nuclear medicine field;

2. To consider what constitutes a realistic career ladder in nuclear medicine and how it can be implemented;

3. To consider what kinds of recruitment materials need to be generated and how they should/could be generated;

4. To consider the collection of critical incidents and identify ways in which they can be used;

5. To set priorities for developing materials for use by clinical instructors in instructing and evaluating the performance of students in the clinical setting;

6. To discuss various dimensions of the variety of NMT training programs which presently exist.

A description of Dr. Anderson's Clinical Instructors Training program and the comments of participants were included in the sourcebook. A report of the career ladder activities was deferred at this time as being premature. Discussions about recruitment determined that high school students were the most difficult to reach, and TERC resolved to engage in further activities to do with student recruitment.

Third NMT Workshop, Atlanta, Georgia, July 8-9, 1971

The initiative for this workshop came from a number of participants in the NMT Interactive Network who were concerned about possible duplication of effort in developing instructional materials in the NMT field. TERC followed up on this concern by first surveying 21 NMT programs to determine the current situation regarding which instructional materials are used the most, what materials are being developed, and in what areas are the most pressing needs for materials.

Following this survey, workshop was held attended by twenty NMT educators, employers, and professionals with the following objectives:

1. To collect evaluative information on the textbooks, audiovisuals, and other instructional materials currently being used in NMT educational programs;
2. To discover any new instructional materials that have been or are being developed by people in the field for use in their, or other, NMT programs; and
3. To discuss with these persons the most pressing needs for the development of new instructional materials - both in terms of subject and media.

The results of TERC's survey and the discussions which ensued in the third workshop are included in the sourcebook. One of the conclusions of the workshop was that audiovisual (slide-tape) units were needed to supplement existing NMT instructional materials. TERC undertook a sample series of Visual Task Descriptions based on a task-by-task analysis as a result of the efforts of the third workshop.

Fourth NMT Workshop, Philadelphia, Pennsylvania, September, 1971 and Fifth NMT Workshop, Tampa, Florida, May, 1972

The fourth and fifth NMT workshops were both concerned with testing out the notions about developing a regional career ladder. The impetus for this workshop grew out of TERC's concern with whether or not it was feasible or necessary to establish a career ladder on a regional basis. The specific objectives of these workshops were:

1. To review the career ladder design and establish its acceptability in the Philadelphia region;

2. To discuss what gaps currently existed in the areas of training and employment in the Philadelphia area necessary for full implementation of career ladder design;

3. To begin to determine who in Philadelphia area might take responsibility for insuring that the career ladder is implemented.

Of all of TERC's efforts in the field of nuclear medicine technology the career ladder concept was perhaps the least successful. Three major factors seemed to account for the lack of effectiveness of career ladder development. First, there is little standardization in nuclear medicine in terms of 1) the number of job levels, 2) the tasks which can be performed by the different levels of technicians, and 3) job titles. Second, the inherently theoretical nature of career ladders limits the immediacy of their interest to NMT trainees, NMTs, and their employers. Third, the variety of educational programs and types of hospitals in which NMTs exist do not readily lend themselves to the development of a career ladder.

It could be said, however, that the process for trying to identify career ladders has generated useful insights into training program design, and encouraged the anticipation of instructional objectives and development of the materials needed to attain them. There are three components of a career ladder system which merit some exploration in the field of nuclear medicine technology: equivalency and proficiency tests, continuing education programs, and graduate follow-up studies.

The career ladder concept was further explored by TERC staff in conjunction with the workshops, and a report was included in the Sourcebook of Working Papers.

Guidance Workshop, December, 1971

The guidance workshop was a joint effort between the biomedical equipment technology project and the nuclear medicine technology project. It was attended by ten representatives from five schools having BMET programs and ten representatives from five NMT programs. Representatives of the programs included an instructor and a guidance counselor. The workshop attempted to sensitize instructors and counselors to one another's problems, thus providing a more favorable climate for the students. Following the workshop, communications with participants indicated that more interaction was indeed taking place between instructors and counselors. Reports of the workshop were disseminated to the field.

A Sourcebook of Working Papers on Problems and Possibilities (1971-72)

In order to communicate the results of TERC's efforts with those in the field, TERC developed the Sourcebook of Working Papers, a three-ring binder to which reports on activities are added as they are completed. The reports included are not to be construed as final or definitive. They are descriptions of surveys, workshops, and critiques of activities from the field.

The sourcebook acted as a vehicle distributing the points of view of TERC and various experts about problem areas in NMT education. As additional activities took place in any of the problem areas, additions were made. The updates were sent to all members of the interactive network who possessed the sourcebook.

The sourcebook is an accumulation of activity reports such as workshops, surveys, and case studies; and division based upon problem areas such as recruitment, clinical training, the NMT task list, emerging areas, critical incidents, and instructional materials. A summary description of the sourcebook's sections follows:

NMT Workshops

The workshops reflected some means and ends that were characteristic of the NMT project's approach. This included:

1. Interaction with a nationwide network of those who train technicians and those who employ them, so that more educators and employers can help to identify and anticipate training requirements;
2. Planning that is sufficiently comprehensive to ensure that action taken to meet these needs is guided by awareness of applicable research and development in nuclear medicine, in NMT training, in learning behavior, in educational technology, and other related fields;
3. Intensification of local employer-educator interaction, and extension of student and teacher access to continuing education, through encouragement of cooperative programs combining work and study; and
4. Periodic development of new instructional methods and materials, so that training programs can remain responsible to changing national employment needs and standards.

Career Ladders

The sourcebook provided a good forum for distributing TERC's view about the career ladder concept with regard to NMTs. As a working paper, inclusion of problems, comments, and recommendations from the field is appropriate, and there can be no misinterpretation of the effort being other than experimental. Thus the sourcebook provides an excellent opportunity for presenting ideas that are speculative.

The report explores the application of the career ladder concept to the field of nuclear medicine technology. Part I provides a description of the career ladder for NMTs and identifies some possible problems in trying to implement it. Part II is concerned with the process of implementing a regional career ladder. This part was based on two workshops for NMT educators and employers.

While the career ladder concept was not adopted by the field, the process of developing it was useful to TERC in determining at what level the model curriculum should aim.

Case Studies

The case studies were originally conducted to enlighten TERC about the state of the art in NMT education. As with all of TERC's work these efforts were shared with the field as soon as they were completed through the sourcebook. The case studies were to ultimately become a project product in themselves since they proposed alternatives to the model curriculum guide.

Recruitment

The task of recruiting students for training programs in NMT is complicated by several factors: the field is unfamiliar to many students, parents, and guidance counselors; it is characterized by considerable fragmentation exemplified by the variety of educational programs; and as a result, no best form of recruitment is possible. Recruitment for most programs was therefore relatively costly. To reduce this cost, TERC applied itself to the problem in conjunction with the field in a variety of ways.

TERC's efforts resulted in an initial recruitment report. This report was based on:

1. A survey of all the professional societies related to NMT, the major manufacturers of nuclear medical instruments, and radiopharmaceutical companies in order to ascertain the types of recruitment materials are available in the field;

2. Discussions with program administrators on their techniques for recruiting students; and

3. One session of the second NMT workshop which focused on recommendations for recruiting high school students.

This report was included in the sourcebook and updated in a report entitled Materials and Methods Useful in the Recruitment of Students into Nuclear Medicine Technology Training Program (April, 1972) which was also included in the sourcebook. The report was based on:

1. The Survey of Job Characteristics, Manpower Needs, and Training Resources (1969)
2. A survey of 53 state and Metropolitan Health Careers Programs, seven professional societies concerned with the development of career opportunities in NMT, government agencies, state and national guidance association, local groups sponsoring career days, high school counselors, NMTs working in hospitals, and students currently enrolled in NMT programs.

Clinical Training

This section of the sourcebook includes the details of sessions from the first workshop concerned with clinical training. The following questions were discussed:

1. Given that there is a need for some generalizable structure for clinical training, what are the constraints to implementing such a structure in most programs?

2. What should be the content of the clinical as opposed to the academic experience--i.e. what skills and tasks are best taught in the clinical setting? How should this determination be made?

3. What teaching techniques are most appropriate for use in the clinical setting?

4. What methods of evaluation are most appropriate for use in the clinical setting?

5. What kind of training, if any, should instructors, responsible for supervising the clinical experience, receive in order to be able to maximize learning in the clinical setting?

Also included are comments from the field about the conclusions and recommendations of the workshop and a description of Miles Anderson's clinical instructors training program.

NMT Task List

Obviously, an understanding of an NMT's tasks is crucial to any attempt to help improve NMT instructional programs. To do this TERC adopted a technique derived from research and experience in military and industrial training. The task list provided the foundation for TERC's curriculum guide and therefore attempts to develop and refine it frequently throughout the course of the project. All of these efforts occurred in the sourcebook since TERC was particularly desirous of obtaining the comments and evaluation of the field. It might be of interest to other researchers to trace the development of this crucial project component. In summary:

1. An initial listing of NMT task or activities was developed by TERC staff with assistance from local NMTs from the NMT national survey (July, 1969).

2. The national survey provided data of what NMTs in hospitals across the country do.

3. Interviews with NMTs in local hospitlas based on this data extended the listing.

4. The extended listing was presented to participants of the first NMT Workshop (December, 1971) and further refined.

5. Inclusion in the sourcebook elicited comments from the field, which were also listed in the sourcebook.

This task analysis was useful to TERC both in the development of the course outlines for the curriculum guide and for the development of job task descriptions used in visual aids.

The task list provides another example of the advantages of using working papers to introduce a controversial procedure to the field. To provide NMTs and NMT educators with more background in this technique, a description of the procedure is included as well as a bibliography of reference works in this type of instructional systems development.

Emerging Areas

Instructional programs can be made more responsive to organizational and technological changes in the field if the program components most susceptible to these changes can be identified and if new developments in the field can be anticipated. This section of the sourcebook includes the efforts made by participants in the first workshop to deal with these areas and the comments of five well-known physicians about emerging areas in nuclear medicine technology likely to have implication on the preparation of NMTs.

At the workshop, participants identified the following four categories to serve as a framework for categorizing changes:

1. Items presently in the research and development stage,
2. Items moving from the research stage into practice in the larger hospitals,
3. Items moving from the larger to the smaller hospitals, and
4. Items which are of decreasing importance and use.

Areas of concern discussed by the physicians included:

1. Instrumentation,
2. Procedures,
3. Radionuclides, and
4. Organizational changes.

Critical Incidents

In the course of TERC's efforts to help the field determine what sorts of instructional materials need to be developed, TERC experimented with a technique known as the Case Study Performance or Critical Incident Technique. This technique is a method of examining important elements of job performance. It involves collecting a large number of descriptions of situations where the effective or ineffective performance of NMTs could have a positive or negative outcome.

Efforts to collect such critical incidents began at the First NMT Workshop. The case format included:

1. Background of the situation,
2. What was done,
3. What happened, and
4. Why it happened.

A sample of twenty-four critical incident case studies was included in the sourcebook in the hopes that others in the field would add to the examples.

Instructional Materials

This section of the sourcebook is based primarily on the Third NMT Workshop. The consensus of the participants at the workshop on instructional materials was that there is a great need for audiovisual units to supplement existing NMT instructional materials. Preceding this workshop, TERC conducted a telephone survey of twenty-one NMT programs to determine the need for materials both in terms of subject and media. The results of the survey and the discussion which followed it at the workshop resulted in a listing of topics for which the greatest need for audiovisual materials existed. In this effort TERC worked closely with the Society of Nuclear Medicine Subcommittee on Audiovisuals.

In summary, it can be said that the Sourcebook of Working Papers enhanced the participation of a variety of representatives in the field. This participation was encouraged by the format of the sourcebook. Its style was informal--the three-ring binder allowed for additions and deletions, thus eliminating the stigma of the preciousness of every printed word. It enabled TERC to get feedback on its activities and thereby to determine which activities should be further developed and which should be dropped. Each section of the sourcebook specifically requested comments from the field and the comments were included. Lists of the participants of each activity were included in the Sourcebook. This provided the interactive network with opportunities to contact those members with similar interests and provided representatives in the field with much-deserved recognition for their efforts.

Recruitment Materials

The development of a recruitment brochure for Nuclear Medicine Technology was based on the information gathered in the surveys and workshop included in the sourcebook. TERC staff observed NMTs working locally to determine what a typical day in the life of an NMT is like. It included a description of an NMT, discussion of employment opportunities, advancement, educational requirements, who to contact for further information, and a listing of NMT training programs. This brochure has been distributed to interested agencies, institutions, and individuals across the country (August, 1972).

NMT Curriculum Guide (1974)

From the inception of the project it was recognized that administrators and NMT program developers needed an overall NMT program planning guide which would summarize recommended procedures and guidelines for establishing NMT programs and would contain detailed information on recommended NMT curriculum.

This guide entitled Nuclear Medicine Technology: A Suggested Postsecondary Curriculum (236 pp) was developed in close cooperation with leading NMT experts and with the six NMT professional societies during the period 1971-1974. It was completed in 1974 and is a major accomplishment of the NMT project. It's development is disucssed in more detail in the following section of this report.

CURRICULUM DEVELOPMENT

Background

A difficult problem in any emerging occupational field is the lack of consensus among employers, professionals, and educators in the field as to the content and format of a quality curriculum for technicians in the field. This is particularly critical in a health related field such as nuclear medicine technology where accreditation of technician programs is an important factor. At the time the NMT project began there was no consensus in the field as to the appropriate curriculum for an NMT program. Developing such a consensus required close and continuing cooperation among the NMT project staff, nationally leading NMT experts, the six NMT professional societies, and the AMA Council on Medical Education, which is the accrediting authority in the NMT field.

The NMT project recognized from its inception that achieving some degree of consensus in the NMT field was vital to widespread implementation of NMT programs and that the NMT project could coordinate the development of a generally acceptable curriculum guide. Accordingly the project staff worked closely on curriculum development over a period of four years with members of the AMA Joint Review Committee on Nuclear Medicine Technology, representatives of the six societies, and representatives from the leading NMT programs. In 1974 an NMT curriculum was completed which was acceptable to all six NMT professional societies and which meets the AMA requirements for an accredited associate degree program in nuclear medicine technology. This curriculum which is contained in the curriculum guide Nuclear Medicine Technology: A Suggested Postsecondary Curriculum should greatly facilitate the implementation of new NMT programs.

Development of the Curriculum Guide

The curriculum guide was twice reconceptualized before it emerged in its present form. The first reconceptualization had to do with content, and the second with format.

Considerable attention was originally given to the possibility of broadening the curriculum outline to include industrial nuclear technology because of its many commonalities with nuclear medicine technology. This would have provided opportunities for establishing core courses to give the student more freedom and a greater choice of careers as well as future mobility. Since the effort involved in nuclear medicine technology turned out to require far more then the development of curriculum course outlines, this plan was dropped.

What emerged as the present curriculum guide had originally been planned as two separate documents: a program planning guide and an instructor's guide. This plan proved to be unrealistic because of the way nuclear medicine technology programs were established. The interface between the planners of the program and the instructors--both academic and clinical--is crucial from the outset and the coordination efforts involved make it imperative that instructors be informed and involved at all stages in the planning process.

Several key events and meetings influenced the development of the guide in addition to the original national survey, the case studies, and the problem areas discussed in the sourcebook. These include the following:

1. The standards established in 1969 by the Council on Medical Education of the American Medical Association in the Essentials of an Accredited Educational Program in Nuclear Medicine Technology.

2. NMT project staff's attendance at the Society of Nuclear Medicine National Meeting in Los Angeles in October, 1971. The NMT project staff met with fifteen experts to determine how the NMT project might coordinate a national effort to develop nuclear medicine technology curriculum guidelines which would be acceptable to the American Medical Association's Joint Review Committee. This Joint Review Committee is made up of representatives of the American College of Radiology, American Society of Clinical Pathologists, American Society for Medical Technology, American Society of Radiologic Technologists, Society of Medical Technologists, and Society of Nuclear Medicine. Since the committee is responsible for accrediting NMT programs, the participation of these representatives ensured that the resulting curriculum guide would meet the standards required for program accreditation.

3. NMT Curriculum Guide Workshop, Chicago, Illinois, April 22-28, 1972

   All six professional societies represented on the Joint Review Committee nominated members to serve on the curriculum guide committee. At the first meeting a format for the guide was selected, and major topics and subtopics for each of the twelve courses listed in the AMA Essentials were agreed upon, as well as their sequence and essentialness to NMTs. The Committee agreed that performance objectives should be written for each course.

4. NMT Curriculum Guide Workshop, Boston, Massachusetts, July 8-9, 1972

   Topic depth and sequence ratings for the twelve courses listed in the AMA Essentials were completed. Most of the instructional objectives were written and reviewed. The efforts resulted in a draft instructor's guide that met with the approval of the six major professional societies of nuclear medicine technology.

At this point a decision had to be made as to the use and the final format of the curriculum guide. It was decided that this document would be representative of all that the NMT project had learned about the education of NMTs, and a model curriculum was formulated. Curriculum outlines were re-evaluated and reviewed so that a comprehensive two-year NMT program emerged. The curriculum outlines included not only those courses which were required by the AMA Essentials, but in addition those which were suggested for graduation from an associate degree program. While the curriculum guide remained adaptable to both four-year and hospital-based programs, it provided the field with a model for two-year school-hospital affiliated programs.

The following five points were taken into consideration in designing the curriculum:

1. The curriculum was designed to meet AMA Essentials of an Accredited Program in Nuclear Medicine Technology.

2. The program graduate should be prepared to pass a national certifying exam for NMTs.

3. The graduates should have a basic foundation in all of the branches of NMT and can later choose to specialize in imaging, in vitro laboratory work, or radiopharmaceuticals if they so desire.

4. Courses in general education should be included to help the student to better understand and communicate with people.

5. Class work and laboratory or clinical practicum should be integrated to reinforce learning. Lectures generally precede laboratory exercises.

The content of the majority of the courses in the curriculum deals with topics required by the AMA Essentials. On an individual topic level as well as in sum, AMA requirements are everywhere exceeded in this program.

Students receive hospital experience where they are supervised by a clinical instructor--a staff nuclear medicine technologist. The practicum is divided into three phases: observation of procedures, participation under close supervision, and performance under loose supervision. Approximately 1,000 hours are spent in the practicum program.

More than fifty experts in the NMT field participated actively in the curriculum guide workshops, in preparing the individual course outlines and performance objectives and in reviewing the curriculum guide. A list of these key contributors is shown in the appendix.

As finally constituted the curriculum guide provides administrators and instructors with a model that can be adapted to their particular situations and needs. It is to be hoped that the stress on careful planning, whether according to the model provided or one which is devised by the users, is observed.

Contents of the NMT Curriculum Guide

The first few sections of the more than 200-page NMT Curriculum Guide is a summary NMT program planning guide designed to assist a school administrator decide whether or not to start an NMT program and plan the establishment of the program. The remainder of the guide is primarily intended to assist the dean of instruction, the department head, and instructors in planning the detailed curriculum. The major topics covered by the guide in sequence are as follows:

1. The Nuclear Medicine Technology Program. It is assumed that a college educator will not have much knowledge about a field as new as nuclear medicine technology. This section contains an overview of the NMT field, discusses special abilities of Nuclear Medicine Technicians, tasks of NMT's, certification of NMT's, and employment opportunities for NMTs.

2. Resources Required. The nuclear medicine technology program is one of the most expensive that a two-year postsecondary school can offer. The administrator is cautioned that the school must have the financial resources as well as the curriculum resources for establishing such a program. Technical specialty courses in NMT are clearly delineated. Since clinical affiliations are a requirement for accredited programs the ability to provide the necessary clinical experience through nearby hospitals is also stressed. Recommendation is made that both this resource and the need for additional NMTs in the area be confirmed through a survey of nearby hospitals. Capital requirements are discussed.

3. Local Needs and Resources Survey. Since more than one institution will be involved in an NMT program (a school and one or more hospitals) careful planning and cooperation is the key to a successful program. This section contains suggested procedures for carrying out a local needs and resources survey including especially a canvass of nearby hospitals.

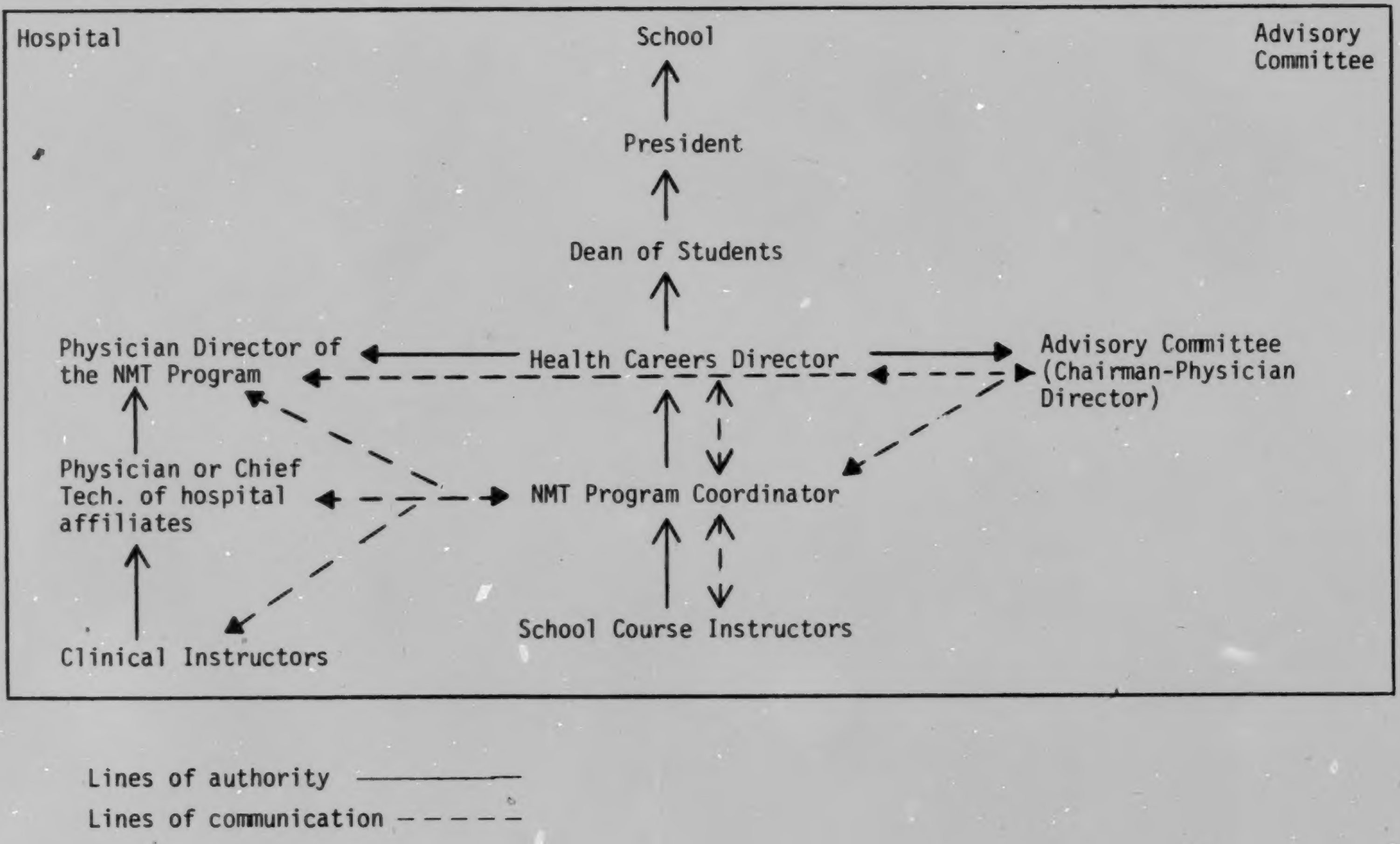
4. Program Advisory Committee. Effective functioning of the NMT Program Advisory Committee is crucial. This section recommends procedures for establishing this committee and selecting its members.

5. Faculty. The AMA Council on Medical Education requires that the NMT program director be a physician qualified in the clinical use of radionuclides. The Physician Director is responsible for the entire program and is primarily responsible for the quality of clinical training. This section describes the positions of the Physician Director, the NMT Program Coordinator, recruitment of faculty members, teaching load, and additional considerations related to faculty.

6. Organization Between the School and Hospitals. This section contains suggestions for establishing a sound organizational relationship between the school and cooperating hospitals. A model for the organization of an affiliated program in nuclear medicine technology as suggested in the guide is shown in Figure 5 on the following page. The lines of authority at the school are quite clear. At the head of the hierarchy is the President of the College, followed by the Dean of Faculty, the Chief of Health Career Programs, the NMT Program Coordinator, and the course instructors in descending order. All these participants are employed by the college.

   The lines of authority concerning the hospital personnel are more complicated. The physician director has responsibility for the entire program. This includes responsibility for the quality of clinical instruction at all the affiliated hospitals and the responsibility for clinical instructors of institutions other than his or her own. These instructors will naturally have loyalties to their own institution. This potentially confusing situation can be solved by the careful delineation of authority at the beginning of the program and by providing accessible mediation for problems.

Figure 5. Organizational Model of an NMT Program


Hospital
School
Advisory Committee
President
Dean of Students
Physician Director of the NMT Program
Health Careers Director
Advisory Committee (Chairman-Physician Director)
Physician or Chief Tech. of hospital affiliates
NMT Program Coordinator
Clinical Instructors
School Course Instructors
Lines of authority
Lines of communication

The physician director has the ultimate authority concerning the program. However, the individual through whom the lines of communication will run is the NMT Program Coordinator. Once the initial problem areas of a newly established program have been identified and suggestions have been made for solving them, much of the day-to-day responsibility will fall to this individual. The program coordinator is in the key position for negotiating between the school and the hospitals and should be able to arbitrate decisions which reflect the priorities of all the institutions concerned as well as the students.

7. Laboratory Equipment and Facilities. Laboratory equipment for most of the NMT specialty courses is usually only available within hospital NMT departments. This section briefly outlines school laboratory requirements. A more detailed description of model school NMT laboratories is given in a later section of the guide.

8. Learning Resource Center. An active Learning Resource Center is particularly important in a rapidly changing field such as nuclear medicine technology.

9. Student Recruitment, Selection and Services. Suggested procedures for NMT student recruitment, selection, counseling, and other student services are discussed in this section.

10. Curriculum Outline. This section contains a summary of a comprehensive two-year NMT curriculum which meets the AMA requirements for an accredited associate degree program in nuclear medicine technology. The curriculum outline and brief description of courses, and a diagram of the curriculum flow are shown on the following five pages as taken from the Curriculum Guide. A chart showing the NMT curriculum flow is shown in Figure 6.

11. Course Outlines and Performance Objectives. This section contains more than 150 pages of detailed recommended course outlines and performance objectives for each of the nineteen courses comprising the model NMT program.

THE CURRICULUM

Nuclear Medicine Technology Curriculum Outline

FIRST SEMESTER

	CLASS HOURS	LAB HOURS	OUT-SIDE STUDY	TOTAL HOURS
Introduction to NMT & Hospital Orientation	2	3	4	9
Radiation Physics	3	0	6	9
Applied Mathematics	3	0	6	9
Anatomy, Physiology & Pathology I	3	2	6	11
Communications Skills	3	0	6	9
TOTAL	14	5	28	47

SECOND SEMESTER

	CLASS HOURS	LAB HOURS	OUT-SIDE STUDY	TOTAL HOURS
Radiation Safety & Radiation Biology	3	0	6	9
Nuclear Instrumentation I	3	3	6	12
Anatomy, Physiology & Pathology II	3	2	6	11
Chemistry for the Health Sciences	3	3	6	12
Medical Terminology	2	0	4	6
TOTAL	14	8	28	50

SUMMER

1. Studies to meet special requirements of state or institution, if necessary.
2. Optional clinical practicum of 10-12 weeks in hospitals.
3. Remedial work, if necessary.
4. 2 week hospital concentration.
5. Summer work for those entering in second year.

THIRD SEMESTER

	CLASS HOURS	LAB HOURS	OUT-SIDE STUDY	TOTAL HOURS
Nuclear Instrumentation II	3	3	6	12
Clinical Practicum I	0	14	0	14
Clinical Nuclear Medicine Technology I	3	2	6	11
Fundamentals of Radiochemistry & Radiopharmaceuticals	3	3	6	12
TOTAL	9	22	18	49

FOURTH SEMESTER

	CLASS HOURS	LAB HOURS	OUT-SIDE STUDY	TOTAL HOURS
Social Psychology for the Health Sciences	3	0	6	9
Clinical Practicum II	0	20	0	20
Clinical Nuclear Medicine Technology II	3	0	6	9
Technical Reporting	3	0	6	9
TOTAL	9	20	18	47

SUMMER

	CLASS HOURS	LAB HOURS	OUT-SIDE STUDY	TOTAL HOURS
Clinical Practicum III (12 weeks)	0	40	9	40

Brief Description of Courses

FIRST SEMESTER

Introduction to Nuclear Medicine Technology and Hospital Orientation

Hospital organization is presented as well as the relationship of nuclear medicine services to other hospital services. Student observations in affiliated hospitals are correlated with lectures on NMT, hospital ethics, patient care, and emergency procedures.

Radiation Physics

The concept of energy and its application to the atom and nucleus is introduced. Radioactive decay, the common radiation units, and the interaction of radiation and matter are stressed.

Applied Mathematics

A review is made of arithmetic, algebra, basic trigonometry functions, logarithms, and graphing. Examples are provided for course relevance to NMTs.

Anatomy, Physiology & Pathology I

A detailed study of the structure and function of the normal human body at the microscopic (cell) level and gross (organ) level is presented. This course also introduces pathological conditions the diagnosis of which may require services of the nuclear medicine facility.

Communications Skills

This course is designed to improve the student's listening, reading, conversational, and writing skills and to assist him in the development of language power.

SECOND SEMESTER

Radiation Safety & Radiation Biology

The guideline regulations for radiation safety in terms of the units of exposure are explained, and the student will be familiarized with instruments and devices which monitor radiation levels. Techniques for safe handling of radioactive material is emphasized. Elements of radiation biology include interaction of radiation with the cell genetic damage, and delayed effects such as carcinogenesis.

Nuclear Instrumentation I

The first semester of this two-semester course parallels Radiation Safety and Radiation Biology with a discussion of instruments used for radiation surveys and personnel monitoring. Radiation safety principles are demonstrated in the laboratory. A study of the components of scintillation detectors and the theory of counting statistics conclude the course.

Anatomy, Physiology & Pathology II

This course covers the respiratory, excretory, digestive, and circulatory systems in lectures, demonstrations, and labs. It concludes with an introduction to immunology.

Chemistry for the Health Sciences

This course includes the basic theories of inorganic chemistry, organic chemistry, and biochemistry. In the laboratory the student learns to operate a pH meter, centrifuge, balance, filtering flasks, and to use the various pipets.

Medical Terminology

The student's vocabulary of medical terms, including the meaning of the common prefixes and suffixes, is developed.

THIRD SEMESTER

Nuclear Instrumentation II

This course is a continuation of Nuclear Instrumentation I. The use of imaging systems, including the principles of their operation are emphasized. Laboratory exercises for this course will generally take place at affiliated hospitals because of the costly equipment involved.

Clinical Practicum I

Observation of nuclear medicine technician duties at one or more hospitals is provided for the student.

Clinical Nuclear Medicine Technology I

This course reviews the concepts of anatomy, physiology, pathology, and radiopharmaceuticals as they relate to the various clinical nuclear medicine procedures. Laboratory exercises are designed to reinforce these concepts.

Fundamentals of Radiochemistry and Radiopharmaceuticals

The student is introduced to fundamental chemistry concepts, generator systems for obtaining radionuclides, and the quality control techniques for validating test results.

FOURTH SEMESTER

Social Psychology for the Health Sciences

A study of psychological principles that will be of assistance in the understanding of interpersonal relations are presented. Motivation, emotion, perception, and learning are among topics considered with reference to effective individual and group behavior.

Clinical Practicum II

Nuclear medicine technician duties are practiced by students under close supervision at one or two hospitals.

Clinical Nuclear Medicine Technology II

This is the second part of a two-semester course. The practical details of the various commonly performed procedures in nuclear medicine are presented including imaging (both static and dynamic and *in vitro* tests.

Technical Reporting

The literature of nuclear medicine technology is introduced through library research projects forming the basis for oral and written reports.

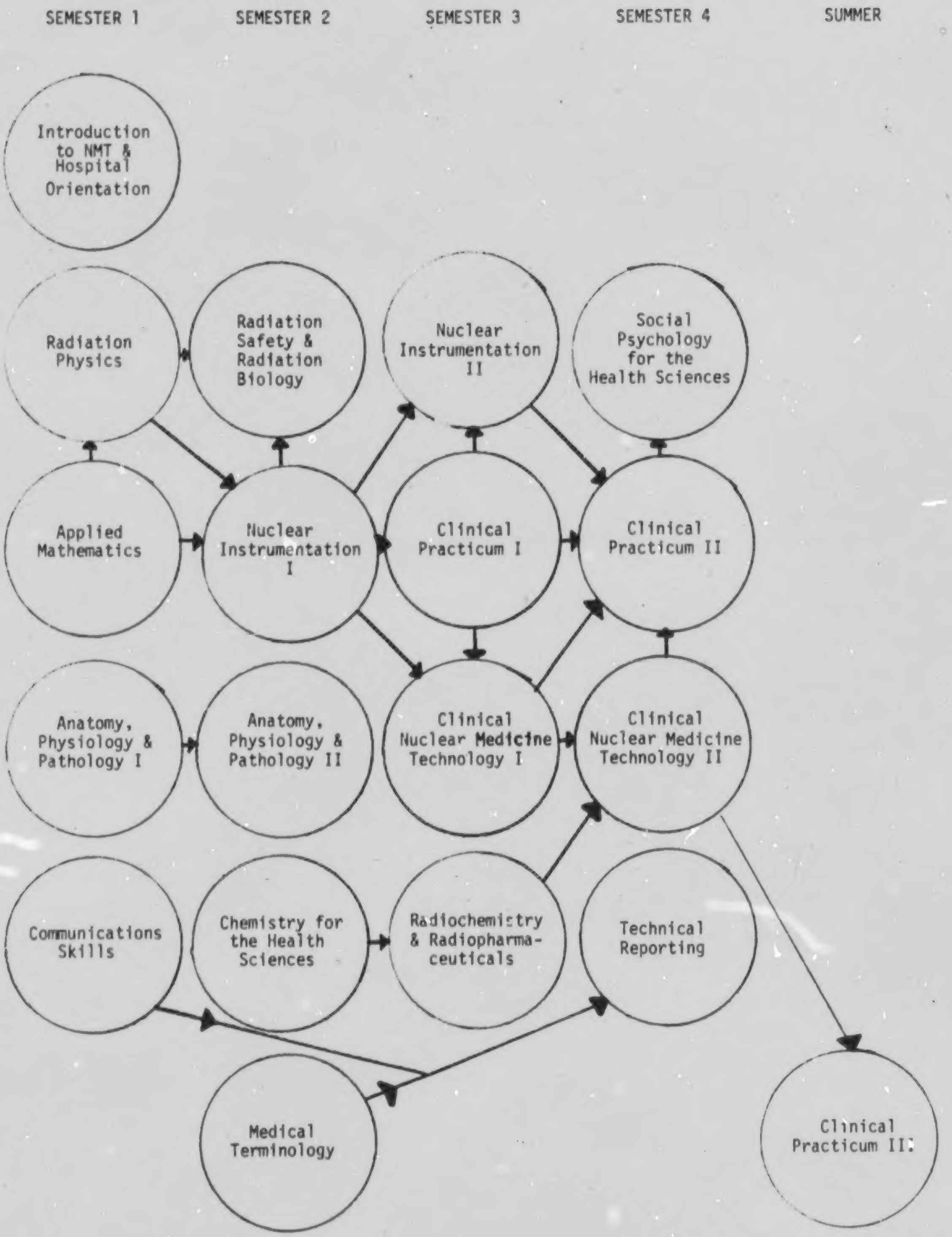
SECOND SUMMER (12 weeks)

Clinical Practicum III

Student practice of nuclear medicine technician duties under limited supervision at a hospital.

FIGURE 6

NMT CURRICULUM FLOW


SEMESTER 1
SEMESTER 2
SEMESTER 3
SEMESTER 4
SUMMER
Introduction to NMT & Hospital Orientation
Radiation Physics
Radiation Safety & Radiation Biology
Nuclear Instrumentation II
Social Psychology for the Health Sciences
Applied Mathematics
Nuclear Instrumentation I
Clinical Practicum I
Clinical Practicum II
Anatomy, Physiology & Pathology I
Anatomy, Physiology & Pathology II
Clinical Nuclear Medicine Technology I
Clinical Nuclear Medicine Technology II
Communications Skills
Chemistry for the Health Sciences
Radiochemistry & Radiopharmaceuticals
Technical Reporting
Medical Terminology
Clinical Practicum III

12. Laboratory Layout and Equipment Lists. This section of the curriculum guide contains a suggested laboratory layout and equipment lists for a 20-student school laboratory for Radiochemistry and Radiopharmaceuticals and Nuclear Instrumentation. It also contains a room layout for a smaller Radiation Science Laboratory including a lecture/demonstration area for twelve to eighteen students with a laboratory area for six to eight students. This section also covers safety regulations for use of radioactive substances, recommended laboratory equipment listings, and costs.

13. Appendices. Several appendices are included in the curriculum guide which provide the following supplementary information to NMT program planners:

    AMA Essentials of an Accredited Educational Program in NMT

    Regulatory Bodies in the Field of NMT

    Sample School and Hospital Affiliation Agreement

    Sample Questionnaire for Assessing the Need for an NMT Program and Available Clinical Resources

    Professional Societies Pertinent to the Education of NMTs

    AEC Application for By-product Material License

    An Annotated List of Audiovisual Suppliers

Study of Combined NMT/NT Curricula

The NMT project explored the feasibility of combined educational programs for nuclear medicine technicians (NMTs) and for nuclear technicians (NTs). Nuclear technicians are primarily employed in nuclear power generation and other nuclear applications in industry. Although some commonalities exist, it was found that these related fields are sufficiently different as to require quite different curricula. A separate project for the development and evaluation of postsecondary programs in nuclear technology was undertaken by TERC in 1974.

INSTRUCTIONAL MATERIALS DEVELOPMENT

In many emerging technologies a lack of relevant instructional materials seriously inhibits development of educational programs. In such fields a coordinated program development project must devote intensive effort to developing needed instructional materials. In the NMT field a major instructional materials development program did not prove necessary since many adequate NMT materials had already been developed in connection with existing hospital-based NMT programs.

Nonetheless a few gaps in available instructional materials were identified as a result of the NMT workshops and the NMT project developed several types of NMT instructional materials to fill these gaps. The first type were a series of 24 Case Studies of Performance based on the Critical Incidents Technique developed by John Flanagan* and others. These case studies were developed as a result of the first NMT workshop and were disseminated to the field in the Sourcebook of Working Papers on Problems and Possibilities.

Discussions with experts in the nuclear medicine field in 1971 led the NMT project to realize the need for collection and maintenance of an increasingly comprehensive, annotated inventory of instructional materials currently available for the education of NMT's. The first step in the inventory process was the Third NMT Workshop (held July 8-9, 1971) involving persons concerned with NMT educational programs and with the development of instructional materials for use in such programs.

Preliminary to the workshop, telephone discussions were held during May, 1971, with twenty-one instructors of nuclear medicine technicians to determine the current situation regarding instructional materials being used in NMT educational programs.

The purpose of the telephone interviews were as follows:

1. To collect evaluative information on the textbooks, audiovisuals, and other instructional materials currently being used in these programs;
2. To discover any new instructional materials that had been or were being developed by people in the field for use in their, and other, NMT programs; and
3. To discuss with these educators the most pressing needs for the development of new instructional materials--both in terms of subject and media.

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* Flanagan, John C. "The Critical Incident Technique." Psychological Bulletin 51:327-358; 1954.

A summary of the eight basic texts and references used in NMT programs as determined by this survey was disseminated to the field through the NMT Sourcebook.

The consensus of participants at the Third NMT Workshop held in Atlanta in July, 1971 was that although existing NMT texts were adequate there was a need for audiovisual units--specifically slide tape units--to supplement existing NMT materials. In response to this need the NMT project experimentally developed task related audiovisual learning units called Visual Task Descriptions (VTDs).

A Visual Task Description (VTD) series is a series of learning modules. Each learning module provides a step-by-step description of a specific job task. The description consists of photographs of each step of the task accompanied by simple, direct text. Also included in each module is a Learner Activity Guide (LAG). The LAG contains an overview of the task described and the prerequisites necessary to perform the task. This is followed by a statement defining the performance objectives and the equipment required to perform the task. Optional references are suggested to supplement the VTD with the underlying theories behind the task. A list of the technical terms related to the performance of the task is included with each module.

VTDs have several applications. They may be used by students as a self-learning tool, by clinical instructors as a supplement to their instruction, and as a guide for procedures to be learned in the clinical setting, and as a script for audiovisuals.

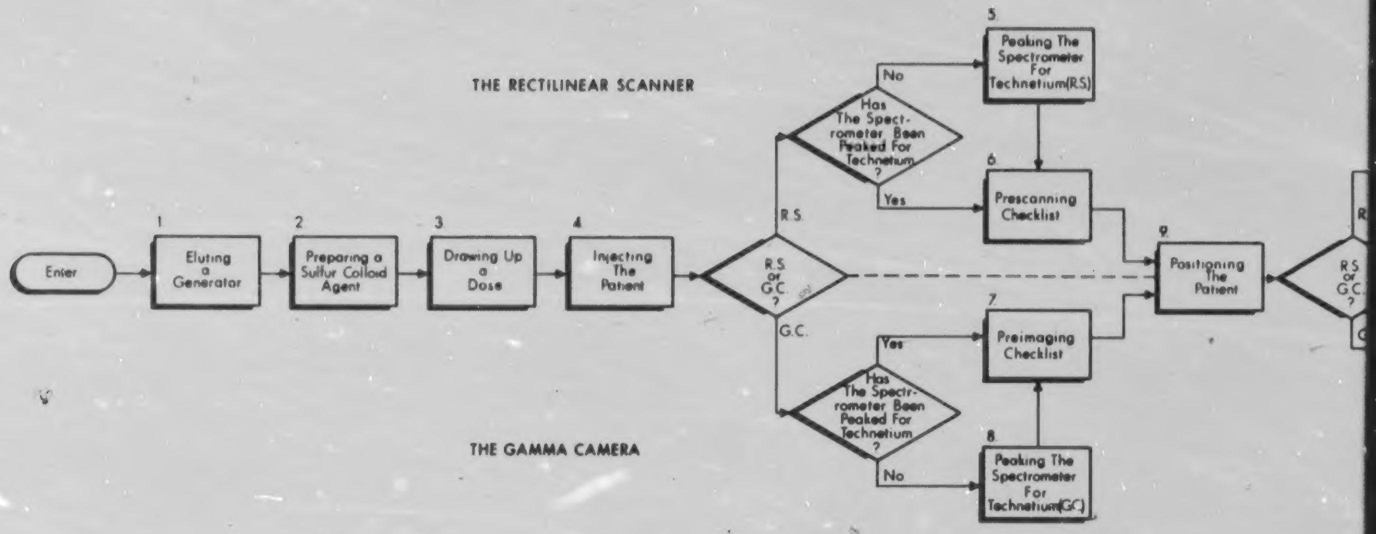
The VTD series can be easily revised to meet the requirements of unique teaching situations, equipment, and students. All that is needed to make the desired changes is an inexpensive camera, scissors, and paste. The modules are designed in such a way that the physician or head technologist can quickly insert the specifications of an individual department. This overcomes one of the major objections by the field to many of the materials presently available.

The VTD Series developed by the NMT project as an example was entitled "Performing the Liver Scan" and consists of fifteen VTD learning modules. Each module covers a task necessary to perform a liver scan which is one of the most frequently performed procedures in nuclear medicine technology.

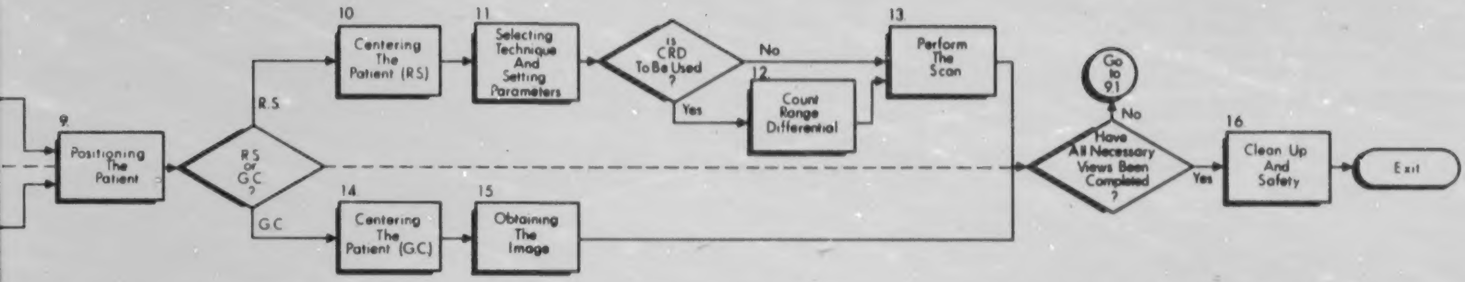
In developing the Liver Scan Series a Job Task Flow Diagram as shown in Figure 7 was first devised based on the NMT task list. The following fifteen VTD Learning Modules were then developed based on the Job Task Flow Diagram each covering one of the job tasks shown in Figure 7.

FIGURE 7

A JOB TASK FLOW DIAGRAM FOR PERFOR


THE RECTILINEAR SCANNER
THE GAMMA CAMERA
Enter
1 Eluting a Generator
2 Preparing a Sulfur Colloid Agent
3 Drawing Up a Dose
4 Injecting The Patient
R.S. or G.C. ?
R.S.
G.C.
Has The Spectrometer Been Peaked For Technetium ?
No
Yes
5 Peaking The Spectrometer For Technetium(R.S.)
6 Prescanning Checklist
7 Preimaging Checklist
8 Peaking The Spectrometer For Technetium(G.C.)
9 Positioning The Patient
R.S. or G.C. ?

FLOW DIAGRAM FOR **PERFORMING A LIVER SCAN**


9.
Positioning The Patient
R.S or G.C ?
R.S
G.C
10
Centering The Patient (R.S)
11
Selecting Technique And Setting Parameters
Is CRD To Be Used ?
No
Yes
12.
Count Range Differential
13.
Perform The Scan
14
Centering The Patient (G.C)
15
Obtaining The Image
Have All Necessary Views Been Completed ?
No
Go to 9.1
Yes
16
Clean Up And Safety
Exit

1. Total or Serial Elution of a Generator
2. Preparing a Sulfur Colloid Agent
3. Drawing Up a Radioactive Dose
4. Patient Pre-examination Checklist
5. Peaking the Spectrometer of the Rectilinear Scanner
6. Peaking the Spectrometer of the Gamma Camera
7. Prescanning Checklist for the Rectilinear Scanner
8. Preimaging Checklist for the Gamma Camera
9. Positioning the Patient on the Rectilinear Scanner
10. Positioning the Patient on the Gamma Camera
11. Centering the Patient for the Rectilinear Scanner
12. Centering the Patient for the Gamma Camera
13. Performing the Scan on the Rectilinear Scanner
14. Obtaining the Image with the Gamma Camera
15. Cleanup and Safety Procedures

A typical VTD Learning Module "Preimaging Checklist for the Gamma Camera" is shown in the appendix.

The VTD Series on Liver Scans was well received by leaders in the NMT field. As a result of the sample VTDs Nuclear Associates granted TERC funds to develop an audiovisual with student workbooks called "The Brain Scan Examination Procedure." This audiovisual provides the student NMT technician with some knowledge of how to develop rapport with patients. Thirty-one other desirable VTD Series were identified by the NMT project. However in view of budget constraints and more urgent priorities, the NMT project did not attempt to develop these additional VTD series. It is hoped that at a later date funding may be available to develop other VTD series.

NMT INTERACTIVE NETWORK - A MECHANISM FOR PROGRAM DEVELOPMENT AND DISSEMINATION

As pointed out previously when the NMT project began in 1968 the nuclear medicine field was rather fragmented. The field involved more than 5,000 licensed nuclear medicine physicians, and nuclear physicists, 200 hospitals with nuclear medicine facilities, six (6) major professional societies, and a variety of pharmaceutical companies, nuclear medicine equipment manufacturers and other employers.

Since little systematic information was available as to the structure, needs, and training resources of this rapidly growing field, the NMT project as its first major activity carried out a systematic occupational analysis of the NMT field. This national survey conducted in 1969 has been described previously. In addition to obtaining needed information about the structure and dynamics of the NMT field, a major purpose of the national survey on NMT needs and resources was to identify key individuals and institutions in the NMT field, to explain to them the purposes of the project, and to enlist their support and cooperation in the development of needed NMT educational programs throughout the country. The national survey and the resulting publication: Survey of Job Characteristics, Manpower Needs and Training Resources were warmly received by NMT professionals and employers as significant contributions to the field. It was the NMT project's first step in enlisting the cooperation of the field and made possible the development of the NMT Interactive Network which became a crucial part of the NMT project.

After completing the national needs survey the NMT project staff recognized that needed NMT educational programs could best be implemented by leading NMT professionals and employers working closely together with educators from community colleges, technical institutes and other educational institutions. NMT professionals and technical educators had little previous experience in working together and typically did not know each other. The NMT Interactive Network was therefore conceived as a mechanism for opening communication and bringing together a broad spectrum of employers, professionals and educators for the purpose of improving the quality and availability of NMT education. It was also conceived as a powerful mechanism for the development and dissemination of program planning materials and other products needed by the NMT field.

The NMT Interactive Network was planned to encourage the participation of all employers, educators, and others interested in identifying and meeting key training needs in the field. By serving as a catalyst to cooperative action, the NMT project hoped to help network participants avoid costly redundancy and time consuming efforts in solving common problems. Through workshops, and other means of interaction, the project planned to initiate and document the problem-solving process, to refine the methods and materials that resulted and to make these products and services accessible to any program training NMT's. The NMT project's intention was to reduce the isolation and fragmentation inevitable during the rapid emergence and nationwide application of a new technology and to facilitate development of programs in schools on a sound basis. The strategy of the NMT Interactive Network was similar to that of the BMET Interactive Network which was operated by the TERC BMET project in the field of Biomedical Equipment Technology. These two interactive networks operated independently with entirely different participants but they had a common purpose and similar techniques and each learned from the other.

Formation of the NMT Interactive Network*

The several hundred key individuals who participated in the NMT national needs survey were the initial participants in the NMT Interactive Network. As case studies, workshops, and other research activities were undertaken, new participants were identified. NMT project staff members also attended professional meetings where NMT project activities were discussed to spread the word. As NMT project products became more widely circulated, new names were added to the network. Eventually, the network included all identified NMT training institutions, many employers and NMTs themselves, including both those active in the various professional societies concerned with nuclear medicine and others, not involved in such activities.

An NMT Network Coordinator was appointed to operate the Network. By October, 1971 the NMT Interactive Network included 740 individuals including 138 educators and educational institutions, 34 employers, 254 nuclear medicine physicians and physicists and 314 nuclear medicine technicians. An analysis of the composition of the NMT Interactive Network including a breakdown by HEW regions is shown in the appendix. By 1972 there were more than 1,000 participants in the NMT Interactive Network.

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* The formation and early growth of both the NMT and BMET Interactive Networks is described by L. Allen Parker in "Interactive Networks for Innovational Champions: A Mechanism for Decentralized Educational Change", Cambridge, Massachusetts: Doctoral Thesis, Harvard Graduate School of Education, 1971.

Network participants were kept up to date on all NMT project activities and products. The project assisted participants in solving problems, getting in touch with others in the field, and in learning about the dynamics of their field. The NMT Interactive Network also disseminated project products widely to network participants. Each of these products had a different function in terms of the development of the interactive network as shown by the following examples:

1. The Survey of Job Characteristics, Manpower Needs, and Training Resources, July, 1969 served the purpose of introducing the NMT project to the field of nuclear medicine technology by providing an overall view of what was presently known and what future needs might be anticipated.

2. The Compendium of NMT Programs. Communications links between the respondents of the questionnaire and the project were established. In addition educators, employers, and potential students could find out about existing and planned programs in their areas and establish links with other members of the interactive network.

3. Sourcebook of Working Papers. This document provided the interactive network with a written forum for evaluation and criticism of pilot efforts. The variety of problem areas identified and dealt with through the Sourcebook provided a vehicle for experts in different areas of nuclear medicine technology to express their views.

The network also operated an NMT Information Clearinghouse through personal contact between project staff and individuals requesting information. When an individual requested information from the NMT Network Coordinator about establishing an NMT program, a discussion would usually occur that would be both beneficial to the program planner and provide the project staff with new opportunities to test theories about program planning. Frequently, staff members would refer the request to other members of the interactive network who had experience in dealing with a specific point.

It is difficult to measure the impact of the NMT Interactive Network operations because they were not designed to result in a specific tangible product. However, the network made essential inputs to all NMT project products and was a primary mechanism for disseminating these products so that they could have immediate impact on the field.

DISSEMINATION AND IMPLEMENTATION ACTIVITIES AND ACCOMPLISHMENTS

Program Dissemination/Implementation

One of the major problems facing educational research and curriculum development is the problem of dissemination/implementation of the results of research and development projects. The problem is difficult enough when the project results simply in improved instructional products for an existing and accepted course of study. Here traditional methods of product dissemination are usually sufficient. It is only necessary to convince a publisher that there is sufficient market for the new instructional materials to warrant his undertaking to publish the materials.

The problem is far more difficult when a vocational-technical education research and development project results in major educational program innovation in the sense that it either:

1. Is designed for a new occupation or group of occupations such as NMT with which schools are typically not familiar and for which program planning materials and instructional materials have not previously been available; or
2. Is designed to change not only a single course but, as in the case of NMT, an entire one or two year sequence of courses leading to a particular certificate or degree; or
3. Involves a new approach in teaching which is unfamiliar to most schools such as the use of an individualized learning system or of modularized instructional materials, or career education; or
4. Is addressed to the special needs of a group of students who have not previously been specially addressed by most schools.

Dissemination of new educational programs such as these requires a different and much more sophisticated approach to the dissemination problem than the traditional methods of product dissemination which have been well developed by educational publishers. The objective of program dissemination is the establishment of needed new programs in schools and not merely the adoption of new instructional materials.

Program dissemination in technical and occupational education is typically beyond the interests and capabilities of commercial publishers. Yet it is only through effective program dissemination that major program research and development can have a real impact on the Nation. There is thus a real national need to develop and test effective new techniques of program dissemination.

Some of the difficulties which are inherent in program dissemination can be seen by looking at new programs from the viewpoint of a technical institute or community college. In order to implement a new program, no matter how much needed or how worthy, a school must successfully pass through a series of steps, each of which may prove fatal to the prospects for the new program. These steps are:

1. Awareness

   The school must become aware of the need for the new program and of its availability;

2. Feasibility Study

   The school must study the feasibility of establishing the new program in terms of local student needs, costs, competing programs, etc.;

3. Decision Making

   The school administration must make a decision to establish the new program, provide the funds, and assign the responsibility for detailed implementation or (equally important) the school must make a decision not to establish the program;

4. Detailed Program Planning

   The school must carry out detailed planning activities as to the type of program needed, staff required, curriculum design, layout of laboratories, etc. This step may involve local survey of employers as to program objectives, and may involve staff training, student recruiting, etc.;

5. Initiation of new Program

   The school must employ needed staff, set up facilities, recruit students and begin classes or must refocus existing curricula and provide in-service training for teachers and counselors;

6. Ongoing Operation, Evaluation, Revision

   The school must evaluate, refine, and revise the program.

This process of establishing a new program requires from one to three years of time depending on the state involved and the degree of urgency felt by the school. It is time consuming and expensive and involves risk of failure. Schools seldom have staff personnel who are familiar with the new program. There is always the tendency to reject new programs which were "Not invented here." With all of these obstacles facing the implementation of new programs, it is not surprising that most research and development projects involving major change do not find their way into use or do so only by a very slow process of diffusion.

The problem faced by the NMT project in achieving effective program dissemination/implementation was therefore one which is of general significance to educational research and development projects. Because of its crucial importance to the NMT project and also because of its general significance program dissemination/implementation was a major objective of the NMT project from its inception. A similar and coordinated dissemination/implementation effort was carried out in connection with TERC's Biomedical Equipment Technology (BMET) project.

In the first three years of the project the major NMT dissemination activities were in the form of an information clearinghouse, publications, conferences and workshops, and articles and presentations as summarized below. Some of these dissemination activities are also discussed in the sections on program planning materials and the NMT Interactive Network.

Information Clearinghouse

As described in the previous section the NMT Information Clearinghouse was operated as a part of the NMT Interactive Network. The Clearinghouse provided specific information about NMT programs directly to individuals requesting information. In some cases it referred individuals to other members of the Interactive Network who might have the particular information requested.

Publications

As each project publication was completed the NMT project mailed an announcement of its availability to the approximately 1,000 members of the NMT Interactive Network. The materials were mailed on request. A small charge was normally made to cover necessary costs. More than 10,000 copies of various NMT publications were requested and mailed. Major publications and numbers of copies requested and mailed prior to July, 1974 included:

	Number of Copies
1. Interim Report I: NMT Job Characteristics, Manpower Needs and Training Requirements and Resources (1969)	700

		Number of Copies
2.	Sourcebook of Working Papers: Nuclear Medicine Technology (1971/72)	536
3.	Digest of Educational Programs: Nuclear Medicine Technology (1972 update)	493
4.	Eight Case Studies: Nuclear Medicine Technology (1971)	75
5.	Recruitment Brochure: Nuclear Medicine Technology (1972)	7,466
6.	Career Ladders and Recruitment: Nuclear Medicine Technology (1972/73)	518

These publications together with the new NMT Curriculum Guide and Digest of Educational Programs (1974 update) continue to be ordered. Although these publications are not commercially available because of their small market, TERC expects to continue to make many of these publications availab[illegible] at the lowest possible price which will cover the costs of reproduction and distribution taking into account the small quantities of each publication produced.

Conferences and Workshops

Conferences and workshops sponsored by the NMT project was a second major means of dissemination. Each conference and workshop performed the dual role of involving key personnel in the NMT field in the development of new project products and in disseminating existing project publications. The appendix lists ten conferences and workshops which were sponsored by the NMT project. Several of these have been described in earlier sections of this report.

Further NMT dissemination was accomplished by the attendance of NMT project staff members at more than twenty workshops and conferences sponsored by other agencies. In many cases NMT staff members described the NMT project and project results at these conferences and workshops.

Articles and Presentations

Publication of articles and presentations was a third important means of NMT project dissemination. The appendix lists 25 articles and publications by project personnel. Of particular note was the regular column concerning the NMT project activities which was published quarterly in the Society of Nuclear Medicine's Journal of Nuclear Medicine Technology.

In view of its particular relevance a copy of the article entitled "Program Development for New and Emerging Technical Occupations" by Nelson and Parker which appeared in the April, 1974 issue of the Journal of Research and Development in Education is reprinted in the appendix. This article contains an overview of the lessons learned from the NMT project and the three other emerging technology projects conducted by TERC. A copy of a Technical Education Reporter article describing a typical NMT program and a three part report on Nuclear Medicine Technology also appears in the appendix.

Study of Program Dissemination/Implementation Techniques

In view of the importance of effective program dissemination/implementation to the NMT project and to other projects, the NMT project especially during the last two years of the project, focused major attention on developing and testing systematic strategies and techniques for dissemination/implementation of NMT programs. This effort was coordinated with similar efforts being carried out in connection with the Biomedical Equipment Technology (BMET) project. Some of the dissemination/implementation techniques and activities tried include:

1. NMT program displays at AVA Conventions and ATEA-USOE National Clinics on Technical Education;
2. NMT program need surveys of approximately 2,000 community colleges, technical institutes, and other agencies;
3. Providing expert NMT consulting services and technical assistance services to schools for planning, implementation, and evaluation of new NMT programs;
4. Mailings of information on NMT publications and apparatus;
5. Publication of an issue of the TECHNICAL EDUCATION REPORTER focused on emerging technologies and featuring descriptions of exemplary NMT programs;
6. Development of a comprehensive Program Development Catalog including a broad range of NMT materials and services;
7. NMT Interactive Network Clearinghouse operations;
8. An experimental program for NMT State Coordinators in ten states.

Although time and funding limitations precluded definitive findings as to relative effectiveness of each of these dissemination/implementation techniques, there was no doubt that each of these techniques has value and that effective dissemination and implementation of a major program innovation such as the NMT program requires a carefully orchestrated combination of all of these techniques and perhaps others.

NMT Dissemination/Implementation Accomplishments

Since successful establishment of new NMT programs is the ultimate goal of the dissemination and implementation perhaps the best measure of the NMT project's effectiveness in dissemination and implementation activites is in terms of the growth in the number and variety of new programs implemented in association with the NMT project.

In July, 1968 when the NMT project began virtually no schools were operating comprehensive associate degree level NMT programs. The NMT project budget in its first year was $70,000. In 1969 three schools were operating programs with state and local investments of about $150,000 per year. By 1974/75 there were 31 operating associate degree NMT programs, most of them established with the active involvement of the NMT project. These programs operated on state and local budgets in excess of $1,500,000 compared with the 1974/75 NMT project budget of $200,000. An additional 6 schools are planning NMT programs.

A list of 36 operating and planned associate degree NMT programs which have actively utilized NMT project materials is shown in the appendix. This chart of schools involved in NMT project shows involvement each school has had with the NMT project in five categories: using NMT project materials; assisting in the development of project materials; testing project materials; project site visits; and subjects of project case studies.

Charts of annual growth of NMT programs are shown in Figures 2 and 3 of the Summary section of this report. This impressive growth of NMT programs catalyzed by the NMT project is strong indication of the effectiveness of the NMT project dissemination/implementation activities.

Dissemination/Implementation Lessons

As a result of the experimentation with program dissemination on the NMT and BMET projects a body of program dissemination techniques is evolving which has proved to be effective for these projects and which may have important implications for improved dissemination of other major educational innovations. The common findings of these projects concerning program dissemination may be summarized as follows:

1. Dissemination/implementation of new educational programs does not just happen automatically. It must be worked at intelligently and systematically.

2. Just as effective program development is a complex undertaking involving many inputs which must be planned and coordinated over a period of years, so in our decentralized educational system effective program dissemination also requires many inputs and must be systematically planned and coordinated.

3. To be fully effective, coordinated program dissemination requires several years of continuity to assure that the new program is sufficiently disseminated to reach a "critical mass" of self-sustaining growth. It is believed that this stage will have been reached, when fifty to one hundred programs distributed in nearly every state throughout the country have been successfully established. From that time onward any new school desiring to establish the new program would be able to rely for guidance on an operating program or programs within a reasonable travel distance from the school.

4. A number of strategies and techniques for coordinated program dissemination exist, some of which have been initially tested and found effective.

5. Effective program dissemination/implementation should be carefully tailored to the particular program being disseminated but usually should include at least four elements. Each element should be both effective in itself and make the other three elements more effective. These elements are:

   (1) A small volume publications program for reports, planning materials, counseling materials, student materials which is geared to small printings of as little as 100 or 500 of a particular title;

   (2) A program of short courses for teachers and administrators;

   (3) A program of consulting services and technical assistance services involving a network of state coordinators and consultants available to assist schools and other agencies in planning, implementing, and evaluating new programs;

   (4) A periodical which keeps educators and others up to date on new programs, products, and services.

6. There is a need for the further development, refinement and testing of these new strategies and techniques of coordinated program dissemination building on results accomplished under the NMT and other emerging technology projects.

EVALUATION ACTIVITIES

Major external evaluations of the NMT project and TERC's other emerging technology projects by evaluation teams selected by the U. S. Office of Education were carried out in 1969 and in 1971 and were very helpful to the planning of the projects. The first site evaluation was conducted by a seven man team in October, 1969. The second site evaluation was conducted by an eleven man team selected by the USOE in June, 1971. Both evaluation teams visited the NMT project in Cambridge, Massachusetts. Both site evaluation teams provided very useful project planning suggestions and both teams strongly recommended continued funding of the NMT project to completion.

A third external site evaluation of the NMT project was carried out as a part of the project plan June 21-23, 1972. This evaluation was carried out by a three man external evaluation team consisting of Professor W. Franzen, Dean of Education, University of Missouri, St. Louis; Dr. Bruce Sodee, Hillcrest Hospital and the Nuclear Medicine Institute, Cleveland; and Dr. Robert Plummer, Washtenau Community College, Michigan. A two man evaluation observation team consisting of Dr. Robert Gibson and Dr. Lee Tabis, consultants to TERC, were also present during this evaluation. This evaluation was focused on identifying major strengths and weaknesses in the NMT project and finding ways to improve its activities and procedures to increase its effectiveness. This evaluation provided very useful inputs for planning of the last two years of the NMT project.

Internal evaluation of project activities and products was carried out on a continuing basis throughout the project. As an example, in 1972 four hundred mail survey questionnaires were sent out to a sample of NMT Interactive Network participants who had not been involved in TERC workshops to evaluate the impact of the project on them. The response rate to this survey was 65% with 215 usable questionnaires. This survey permitted evaluation of the effectiveness in the field of each of the NMT program planning publications, and an analysis of the findings of this survey shows that 71% of the respondents had at least heard of the Compendium, 63% had at least heard of the Sourcebook, and 51% had heard of an older document, Survey of Job Characteristics, Manpower Needs and Training Resources. Of those who had heard of the Compendium, 87% had referred to it for information, and 54% considered it "very useful." With respect to the Sourcebook, the NMT task list appears to be the most widely used section. Of those who have used the Sourcebook, 48% indicated that they considered it "very useful."

The literally thousands of contacts between the NMT project and the NMT field also provided continuing informal feedback and evaluation of the effectiveness of various project activities and products. The requests for drafts of the curriculum guide, for information in the Interim Number I Report, the case studies, and the Compendium indicate that the TERC project was meeting certain needs in the field. A less tangible, but important means of evaluation was the degree of cooperation that TERC obtained from the field. Percentages of response to questionnaires have been high and members of the Interactive Network have always been ready to participate in the activities involved in the NMT project.

The comments of field reviewers from the project's final products have also been very positive. This is particularly true of the Curriculum Guide which summarizes many of the other project products. Criticism has been of a constructive nature which has aimed at enhancing the product, not changing it.

Likewise the NMT project has received much positive feedback from school programs which have been established in conjunction with the NMT project. Frequently NMT staff members have heard either by letter or by word of mouth that program planning materials have been helpful in setting up the program or that TERC's course outlines had helped instructors in hospitals, community/junior colleges, technical institutes, and other institutions.

SUGGESTIONS FOR FUTURE COORDINATED PROGRAM DEVELOPMENT PROJECTS

In carrying out this new type of national program development project represented by the NMT project, TERC and the NMT project staff has held an unusual relationship to the NMT field during the six years of the project. Although TERC has worked closely with schools and hospitals in developing new NMT programs, TERC did not itself operate any technician education programs. Its role was that of developer, facilitator, coordinator, and disseminator. As such it has been able to obtain unique insights into the entire process of developing NMT programs. It has learned several important lessons as to how to deal effectively with developing emerging technologies and as to how to intervene effectively with state and local educational and health care systems in order to facilitate the development of needed new programs. It has also learned to work effectively with the several professional societies in the field. Some comments and suggestions for future projects concerned with program development in emerging occupations are summarized below.

The time that a program development project spends in evaluating what it can do and how to proceed is well spent. This information may not be new just to the project. In fact, it is unlikely that each component involved in an emerging area is fully or even partially aware of what the other components are doing. An examination of all components and initial contact with them is crucial to maintaining an awareness of changes which are likely to occur. The results of this examination should be disseminated to the field as soon as possible. In NMT it took the form of the Interim Number I Report. This enables the field to use the information for its further development and serves as an indicator of what the research organization is about to the field.

Having identified the individuals and institutions interested in a particular field, the project establishes an ongoing information clearinghouse which connects the individuals and institutions into a network. The project is then in a position to determine what needs to be done. One of the major roles of the project is to synthesize ideas that come from the network and collect information from the various components. The products resulting from this stage of the project are non-judgmental in nature. For example in the NMT project, there was no "best way" to establish an NMT educational program. The variety of ways that had been attempted needed to be documented so others in the field could try them out. Much material such as case studies developed at this stage of a project may be experimental in nature. Some of it may be disregarded at a later time as not having been effective; some of it will be useful only in a limited way. All of it should involve as much of the interactive network as possible and evaluations from the users are to be encouraged.

Ultimately, it will be possible to delineate models. It is to be assumed that those establishing programs are competent in what they are doing. In the case of nuclear medicine technology this will be the physician director, the person responsible for the NMT program, and the program coordinator, the person from the school who will coordinate the program from the school. By providing these people with guidelines, they will be able to adapt the model to their own specific situation. The experimental materials may also be of use to them in that some of the alternatives which led to the model may have applications in specific situations. For example, many of the activities described in the NMT Sourcebook of Working Papers provide information not found in the Curriculum Guide.

An active network in the field can be one of the lasting efforts of a program development project. After the project is no longer functioning in a particular field this network of individuals and institutions that may have originally been brought together by the catalytic efforts of the project can continue to identify the needs of the field and meet them. In the case of NMT the formal documents serving this purpose were the Compendium of Educational Programs in NMT and its update, the Digest of NMT Educational Programs. This information was disseminated to the field informally through the lists of participants in the Interactive Network and reviewers of project activities to be found in the Sourcebook.

The foregoing comments and suggestions are derived from the special experience of the NMT project. It should be noted again that each project must adapt itself to the special constraints and needs of its field. For the use of future coordinated program development projects an effort has been made to distill the lessons from all four of TERC's emerging technology projects. These general insights about program development are contained in the article "Program Development for New and Emerging Technical Occupations" which appeared in the Spring, 1974 issue of the Journal of Research and Development in Education. This article is reprinted in the appendix to this report. Seven general insights are discussed in that article:

1. Responding to Field Constraints
2. Accepting Local Autonomy
3. Assisting Local Innovators
4. Developing Modular Materials
5. Involving Both Teachers and Developers
6. Recognizing the Limits of Evaluation
7. Encouraging the Interaction of All Concerned with the Field.

This article also describes twelve suggested types of products for a coordinated program development project. Figure 1 shows a somewhat extended list of twenty kinds of products which can facilitate the establishment of new educational programs. The priority to be placed on each product is determined by a field's technology, labor market demands, professional associations, and the educational institutions concerned. Available time and financial resources can also limit a project from developing all of the following products:

1. *Report on job characteristics*, manpower needs, and training resources in an emerging field.

2. *Directory of field participants* compiled from information about all the individuals and institutions concerned with the emerging field.

3. *Collected descriptions of educational programs*, both existing and planned, compiled from information identified during survey.

4. *Plan for facilitating program development* based on the urgent needs identified during survey.

5. *Program planning guide* with suggested steps for establishing an educational program in the field.

6. *Facilities and equipment guidelines* complementary to the program planning guide.

7. *Case studies on program implementation* describing the difficulties encountered and overcome by educational programs for emerging occupations.

8. *Workshops for program planners* to introduce them to the needs and training resources in an emerging field.

9. *Task analysis and performance objectives* for the emerging occupation to use in developing instructional materials.

10. *Performance assessment instruments* which are criterion referenced for evaluating student achievement of the objectives.

11. *Field tested modularized materials* including instructions to the students regarding each module and suggestions to teachers for combining the modules to form a curriculum.

12. *Instructor orientation workshops* for introducing teachers and administrators to the modularized instructional materials.

13. *Materials for recruiting students* which explains the content of the emerging occupation, its career opportunities, and its educational preparation.

14. *Student assessment of programs* by means of questionnaires, confidential interviews, and informal interactions.

15. *Graduate follow-up surveys* to ascertain program strengths and weaknesses.

16. *Counseling guidelines and workshops* for teachers and guidance personnel concerning special student prerequisites for the emerging occupation.

17. *Information clearinghouse* to systematize the sharing of information and materials among all the institutions and individuals concerned with the emerging field.

18. *Periodic updating surveys* to identify new field needs and training resources.

19. *Loose-leaf sourcebook* on problems and possibilities with working papers describing the current challenges for the field and proposed solutions.

20. *New program development projects* to address the current challenges for the educational programs in the emerging technology.

RECOMMENDATIONS

1. Additional Dissemination/Implementation of NMT Programs

The NMT project has succeeded in establishing a sound base for NMT education in the United States. More than thirty community colleges, technical institutes or other institutions have now implemented NMT educational programs in cooperation with the project. This is an excellent beginning but does not yet fully meet the needs of this rapidly expanding field.

As the field has matured in the last few years it has also developed stricter standards of regulations. States are beginning to pass regulations requiring NMTs to be registered. The two organizations that register individuals (ASCP & ARRT) have agreed that as of 1976 only those who have graduated from an NMT program accredited by the AMA Council on Medical Education are eligible to take registry exams. However, a recent survey conducted by TERC shows that only 23% of the baccalaureate programs are accredited, 45% of the associate degree programs, and 61% of the certificate programs. The need for additional systematic NMT dissemination/implementation activities is crucial.

To meet this need it is recommended that an NMT dissemination/implementation project should be initiated and carried on at a relatively low level of funding for a period of three years. This might be done as a part of a broader dissemination/implementation project for emerging occupations or career education programs. The objectives of the dissemination/implementation project would be to facilitate the implementation of additional needed NMT programs throughout the country; to assure that existing NMT programs remain relevant to the changing needs of employers and students; and to work with leaders in the field for the further development of the NMT occupations. Project activities should include:

1. Disseminating NMT planning and instructional materials;

2. Maintaining an active communications network among professionals, educational institutions, hospitals, employers, and all others concerned with NMT education and employment needs in order to maintain the relevance of the NMT program;

3. Providing consultative service and technical assistance to states, schools, and hospitals wishing to implement new NMT programs or wishing to improve existing programs;

4. Conducting conferences, short courses, and staff training workshops for teachers and administrators in the NMT field.

Such a dissemination/implementation project would further increase the impact of the NMT program development project and would be a model for effective dissemination/implementation of other programs developed under USOE sponsorship.

2. A National Program for Careers in New and Emerging Occupations

(1) Rationale

Since 1967 when the four projects began, the pace of change in new and emerging occupations has accelerated. In addition to emerging occupations brought about by technological change many new occupations are now developing as a result of social changes and legislation. More than fifty percent of our citizens are now engaged in service occupations many of which are new and require formal educational preparation beyond the high school. The need for a systematic national program to assist schools to implement needed programs in new and emerging occupations is much greater now than when the NMT project began and this need is continuing to increase. The problem of emerging occupations is inherent and continuing in our complex society and must be faced at the national level if our educational system is to remain relevant to changing economic and social needs.

The problem of educational planning for emerging occupations can be likened to the problem of planning a missile defense system. As a nation we need an early warning system to detect new occupations as they first come across the horizon; we need a tracking system to follow their paths as they grow and develop through time; we need an assessment system to determine the difficulty of developing an educational response to each new occupation; finally we need a flexible response system to provide appropriate assistance to schools for each new occupation.

In planning such a system it is important to recognize that most new and emerging occupations do not produce a critical educational problem as was the case in nuclear medicine technology, biomedical equipment technology, electromechanical technology, and laser electro-optic technology. At any one time there are a number of new and emerging occupations which are at various stages of development and are emerging at various rates. Each new occupation tends to follow the typical growth rate curve of a slow early growth, rapid growth for a few years, followed by a declining growth rate as it becomes mature. New and emerging occupations with relatively low growth rates can be accommodated by schools with minimal outside assistance. Relatively familiar occupations with moderate growth may require only moderate outside assistance. Only very new and unfamiliar fields with high growth rates such as BMET, EMT, LEOT, and NMT schools require major outside assistance in the form of a national program development project.

(2) Recommended Comprehensive National Program

The objective of a comprehensive national program for new and emerging careers is to assure the development of educational programs in new and emerging occupations which are reasonably matched in quantity and quality to the developing needs of employers. Meeting this objective requires an ongoing program to gather information on the entire spectrum of emerging occupations, assess the needs of schools for outside assistance in each, and provide the appropriate kind and amount of assistance required to catalyze needed new program development.

As a result of the four emerging technology projects all of the necessary experience, strategies, and techniques now exist to establish and operate such a national program. It is recommended that immediate and serious attention be given by the U. S. Office of Education to the problem of new and emerging occupations and to the establishment of a national program for careers in new and emerging occupations.

APPENDICES

I.

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CONTRIBUTORS TO NMT CURRICULUM GUIDE

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II.

SCHOOLS INVOLVED IN NMT PROJECT

SCHOOLS INVOLVED IN NMT PROJECT*

Associate Degree Programs

May, 1973

COMMUNITY COLLEGES AND TECHNICAL INSTITUTES, BY STATE	USING PROJECT MATERIALS		ASSISTED IN DEVELOPING TERC MATERIALS (including workshop attendance)	TESTING TERC MATERIALS	TERC STAFF SITE VISITS	CASE STUDIES
	In Operating Program	In Planned Program				
ARIZONA						
Maricopa Technical College		X				
CALIFORNIA						
Loma Linda University/University Hospital	X		X			
San Francisco City College/San Francisco State College/University of California		X				
Los Angeles City College/Area Hospitals	X		X			X
Bakersfield College/Kern General Hospital		X				
U/Southern California/LAC-USC Medical Center		X				
COLORADO						
Community College of Denver/Area Hospitals	X		X	X	X	X
CONNECTICUT						
South Central Community College/Yale-New Haven Medical Center	X			X		

*Note: This list does not include 219 additional schools and hospital based programs (non-associate degree) which have been involved with the NMT Project.

SCHOOLS INVOLVED IN NMT PROJECT

Associate Degree Programs

COMMUNITY COLLEGES AND TECHNICAL INSTITUTES, BY STATE	USING PROJECT MATERIALS		ASSISTED IN DEVELOPING TERC MATERIALS (including workshop attendance)	TESTING TERC MATERIALS	TERC STAFF SITE VISITS	CASE STUDIES
	In Operating Program	In Planned Program				
FLORIDA						
Santa Fe Junior College/Area Hospitals		X	X			
Hillsborough Community College/ Tampa General Hospital, et al.	X		X	X	X	X
ILLINOIS						
Triton College/Area Hospitals	X		X	X		
Wright Junior College/St. Mary of Nazareth Hospital		X				
KENTUCKY						
University of Kentucky Medical Center	X		X			
MARYLAND						
Montgomery College/Area Hospitals		X	X	X		
Essex Community College/Church Home and Hospital/Johns Hopkins Hospital	X		X	X	X	
MASSACHUSETTS						
Springfield Technical Community College		X		X	X	
Middlesex Community College		X	X			

SCHOOLS INVOLVED IN THE NMT PROJECT

Associate Degree Programs

COMMUNITY COLLEGES AND TECHNICAL INSTITUTES, BY STATE	USING PROJECT MATERIALS		ASSISTED IN DEVELOPING TERC MATERIALS (Including workshop attendance)	TESTING TERC MATERIALS	TERC STAFF SITE VISITS	CASE STUDIES
	In Operating Program	In Planned Program				
MASSACHUSETTS (continued)						
Bunker Hill Community College		X		X		
MICHIGAN						
Ferris State College/Area Hospitals	X			X		
Mid Michigan Community College		X	X	X		
NEW JERSEY						
Passaic County Community College		X		X		
Middlesex County College/Area Hospitals	X		X	X		
NEW YORK						
Columbia College of Physicians & Surgeons		X	X	X		
SUNY Upstate Medical Center		X	X			
NORTH CAROLINA						
Central Piedmont Community College/ Area Hospitals	X			X		

SCHOOLS INVOLVED IN THE NMT PROJECT

Associate Degree Programs

COMMUNITY COLLEGES AND TECHNICAL INSTITUTES, BY STATE	USING PROJECT MATERIALS		ASSISTED IN DEVELOPING TERC MATERIALS (Including workshop attendance)	TESTING TERC MATERIALS	TERC STAFF SITE VISITS	CASE STUDIES
	In Operating Program	In Planned Program				
NORTH CAROLINA (continued)						
Forsyth Technical Institute/ Bowman Gray School of Medicine/ N.C. Baptist Hospital	X		X		X	X
OHIO						
University of Cincinnatti	X		X			
OKLAHOMA						
OSU Technical Institute/Area Hospitals		X				
PENNSYLVANIA						
Harrisburg Area Community College Penn. Junior College Medical Arts/ Harrisburg Hospital	X		X	X	X	
SOUTH CAROLINA						
Midlands Technical Community College/South Carolina Baptist Hospital		X		X		
Bunker Hill Community College		X		X		

SCHOOLS INVOLVED IN THE NMT PROJECT

Associate Degree Programs

COMMUNITY COLLEGES AND TECHNICAL INSTITUTES, BY STATE	USING PROJECT MATERIALS		ASSISTED IN DEVELOPING TERC MATERIALS (including workshop attendance)	TESTING TERC MATERIALS	TERC STAFF SITE VISITS	CASE STUDIES
	In Operating Program	In Planned Program				
TENNESSEE						
Aquinas Junior College/Vanderbilt University		X	X	X		
TEXAS						
Galveston Community College/U. Texas Medical Branch	X		X	X		
Dallas County Junior College/ Baylor U. Medical Center		X	X	X		
VERMONT						
University of Vermont Medical Center	X		X	X		X
VIRGINIA						
Western Virginia Community College/Roanoke Memorial Hospitals		X				

III.

UNIVERSITIES, SCHOOLS, HOSPITALS BUSINESSES, AND OTHERS INVOLVED IN DEVELOPMENT OF NMT PROJECT PRODUCTS

POST-SECONDARY SCHOOLS INVOLVED IN DEVELOPMENT OF PRODUCTS

Maricopa Technical College, Ariz.
Los Angeles City College, Los Angeles, Cal.
Los Angeles City College, Cal.
UCLA School of Medicine, Cal.
Orange Coast College, Costa Mesa, Cal.
Fullerton Junior College, Fullerton, Cal.
Los Angeles City College, Cal.
South Central Community College, New Haven, Conn.
Santa Fe Junior College, Gainesville, Fla.
Hillsborough Community College, Tampa, Fla.
Triton Junior College, Rivergrove, Ill.
Montgomery College, Takoma Park, Md.
Ferris State College, Big Rapids, Mich.
Middlesex County College, Edison, NJ
C. W. Post College, Long Island University, Greenvale, NY
Central Piedmont Community College, Charlotte, NC
Harrisburg Area Community College, Penn.
Pennsylvania Junior College of Medical Arts, Penn.
Chattanooga State Technical Institute, Chattanooga, Tenn.
Aquinas Junior College, Tenn.
Galveston Community College, Tx.
Texas State Technical Institute, Waco, Tx.

BUSINESS & INDUSTRY PERSONNEL INVOLVED IN DEVELOPMENT OF PRODUCTS

National Medical Audiovisual Center, Atlanta, Georgia
Argonne National Laboratory, Argonne, Illinois
Nuclear Chicago Corporation, Des Plaines, Illinois
Picker Nuclear, North Haven, Connecticut
Nuclear Data, Inc., Illinois
Ohio Nuclear Inc., Ohio
E. R. Squibb
Victoreen Instrument Division
Raytheon, ME Division
Canberra Industries
Microbiological Sciences, Inc., N. Y.
Baird Atomic, Bedford, Mass.

UNIVERSITIES INVOLVED IN DEVELOPMENT OF PRODUCTS

University of Alabama in Birmingham-- School of Medicine, Ala.
School of Community Health & Allied Resources, and Regional Technical Institute, Ala.
Bakersfield College, Ca.
University of Arkansas at Little Rock, Ark.
University of California, Los Angeles, Cal.
University of Southern California, Cal.
Stanford University, Cal.
Loma Linda University, Cal.
University of California, San Francisco, Cal.
Yale University, Conn.
University of Delaware, Wilmington, Del.
University of Miami, Fla.
Emory University, Atlanta, Ga.
Medical College of Georgia, Augusta, Ga.
Loyola University - Stritch School of Medicine, Maywood, Ill.
Triton College, Rivergrove, Ill.
Chicago Medical School, Ill.
Indiana University, Ind.
University of Iowa, Ia.
University of Kansas, Kan.
University of Kentucky, Ky.
John Hopkins University, Md.
University of Minnesota, Minn.
University of Mississippi, Miss.
University of Missouri School of Pharmacy, Kansas City, Kan.
University of Missouri, Mo.
Mallinckrodt Institute of Radiology, St. Louis, Mo.
University of Nevada, Las Vegas, Nev.
University of New Mexico School of Medicine, Albuquerque, NM
Duke University Medical Center, Durham, NC
N.C. Baptist Hospital - Bowman Gray School of Medicine, Winston-Salem, NC
Temple University, Philadelphia, Pa.
University of Cincinnati, Cincinnati, Oh.,
University of Oklahoma School of Medicine, Oklahoma City, Ok.
Technical Institute - Oklahoma State University, Stillwater, Ok.
University of Oregon Medical School Portland, Ore.
Medical University of South Carolina, SC
Vanderbilt University School of Medicine, Tenn.
Oak Ridge Associated Universities, Oak Ridge, Tenn.
University of Texas Medical Branch, Galveston, Tx.
University of Utah Medical School & Hospital, Salt Lake City, Utah
University of Vermont, Burlington, Vt.
University of Virginia, Va.
Medical College of Wisconsin, Department of Allied Health, Wis.
Washington University, St. Louis, MO
University of Colorado, Boulder, Colo.
Wake Forest University, Winston-Salem, N. C.
Wayne State University, Mich.
Roanoke College, Salem, VA
Cornell University, Ithaca, N.Y.
University of Iowa, Iowa City, Iowa
Harvard University, Cambridge, Mass.
Mass. Institute of Technology, Cambridge, Mass.
University of Omaha, Omaha, Nebraska
University of South Florida, Florida

HOSPITALS INVOLVED IN DEVELOPMENT OF PRODUCTS

Birmingham Veterans Administration Hospital, Alabama
University Hospital, Alabama
Jackson Hospital, Montgomery, Ala.
Good Samaritan Hospital, Phoenix, Ariz.
St. Vincent Infirmary, Little Rock, Ark.
Arkansas Baptist Medical Center, Arkansas
V. A. Hospital, Arkansas
Kern General Hospital, Bakersfield, Calif.
Loma Linda University Hospital, Loma Linda, Calif.
White Memorial Hospital, Los Angeles, Calif.
Memorial Hospital Medical Center, Long Beach, Calif.
St. Mary's Hospital, Long Beach, Calif.
Memorial Hospital of Southern California, Culver City, California
Good Samaritan Hospital, Los Angeles
Veterans Administration Hospital, Sawtelle, Calif.
LAC-USC Medical Center, Los Angeles
Los Angeles County - Univ. of So. Calif. Med. Center, L.A., CA
St. Vincent's Hospital, Los Angeles
V. A. Hospital Wadsworth, Los Angeles
V. A. Hospital, Sepulveda, Calif.
Orange County Medical Center, Orange, Calif.
St. Joseph Hospital, Orange, CA
Long Beach V. A. Hospital, CA
V. A. Hospital, Palo Alto
Stanford University Hospital & School of Medicine, California
Huntington Memorial Hospital, Pasadena
Community Hospital of Riverside, Calif.
Riverside General Hospital, Calif.
Sutter Community Hospitals, Sacramento, CA
Radiation Center Medical Group, Santa Barbara
Penrose Hospital, Colorado Springs, CO.
Penrose Cancer Hospital, CO
Fitzsimons General Hospital, CO
Colorado General Hospital
General Rose Memorial Hospital, CO
Mercy Hospital, CO
Porter Memorial Hospital, CO
Denver General Hospital CO
St. Luke's Hospital, CO
Community College of Denver, CO
Lutheran Hospital & Medical Center, CO
Presbyterian Hospital & Medical Center, CO
St. Joseph's Hospital, CO
Swedish Hospital & Medical Center, CO
Veterans Administration Hospital, CO
Valley View Hospital & Medical Center, CO
St. Anthony Hospital, Denver, CO
Manchester Memorial Hospital, Manchester, Conn.
Yale-New Haven Medical Center, New Haven, Conn.
Wilmington V. A. Hospital, Delaware
Wilmington Medical Center, Memorial Division, Delaware
University of Florida Medical Center
V. A. Hospital, FLA
Jackson Memorial Hospital, Miami, FLA
Mount Sinai Hospital, Miami Beach
Osteopathic General Hospital, N. Miami Beach, Fla.
Tampa General Hospital, FLA
St. Joseph Hospital, FLA
University Community Hospital, FLA

Emory University Hospital, Atlanta, Ge.
Atlanta V.A. Hospital, Atlanta, Ge.
Chicago Wesley Memorial Hospital, Chicago, Ill.
Children's Memorial Hospital, Chicago, Ill.
St. Mary of Nazareth Hospital, Chicago, Ill.
Evanston Hospital, Evanston, Ill.
V.A. Hospital, Hines, Ill.
Mount Sinai Hospital - Chicago Medical, Ill.
Indiana University Medical Center, Indianapolis, Ind.
University Hospitals, Iowa City, Ia.
University of Kansas Medical Center, Kansas City, Ka.
Wesley Medical Center, Wichita, Ka.
St. Elizabeth Hospital, Covington, Ky.
University of Kentucky Medical Center, Lexington, Ky.
Lexington, V.A. Hospital, Lexington, Ky.
Louisville General Hospital, Louisville, Ky.
Charity Hospital of Louisiana, New Orleans, La.
Augusta General Hospital, Augusta Me.
Mercy Hospital, Portland, Me.
Baltimore City Hospital, Baltimore, Md.
Church Home & Hospital, Blatimore, Md.
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Rahway Hospital, Rahway, NJ
St. Elizabeth Medical Center, Elizabeth, NJ
Somerset Hospital, Somerville, NJ
St. Joseph's Hospital, Paterson, NJ
Riverview Hospital, Red Bank, NJ
Overlook Hospital, Summit, NJ
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Roswell Park Memorial Institute, Buffalo, NY
Queens General Hospital, New York City
Long Island Jewish Hospital, New Hyde Park, NY
North Shore Hospital, Manhasset, NY
Nassau County Medical Center, East Meadow, NY
Booth Memorial Medical Center, Flushing, NY
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New York Hospital - Cornell Medical Center, NY
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Forsyth Memorial Hospital, NC
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Baroness Erlanger Hospital, Tenn.
Baptist Memorial Hospital, Memphis, Tenn.
City of Memphis Hospitals - U/Tennessee Medical Units, Memphis, Tenn.
V.A. Hospital, Nashville, Tenn.
Baylor University Medical Center, Dallas, Tx.
William Beaumont General Hospital, El Paso, Tx.
Radiation Center & Medical Branch, Galveston, Tx.
John Sealy Hospital, Tx.
Scott & White Memorial Hospital, Temple, Tx.

University of Virginia Hospital, Charlottesville, Va.
Roanoke Memorial Hospitals, Roanoke, Va.
St. Mary's Hospital, Madison, Wis.
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St. Luke's Hospital, Milwaukee, Wis.
St. Mary's Hospital, Milwaukee, Wis.
Huntsville Hospital, Huntsville, Ala.
Providence Hospital, Mobile, Ala.
Veterans Administration Hospital, Phoenix, Ariz.
Tuscon Medical Center, Tucson, Ariz.
Veterans Administration Hospital, Tucson, Ariz.
University Hospital, University of Arkansas Medical Center, Little Rock, Ark.
Scripps Clinic & Research Foundation Hospital, LaJolla, Calif.
Antelope Valley Hospital, Lancaster, California
Holy Cross Hospital, Los Angeles, Calif.
Long Beach Community Hospital, Los Angeles, Calif.
Memorial Hospital of Long Beach, Los Angeles, Calif.
St. John's Hospital, Los Angeles, Calif.
University of California at Los Angeles Hospital
Queen of the Valley Hospital, Napa, California
Alta Bates Community Hospital, San Francisco, California
French Hospital, San Francisco, Calif.
Letterman General Hospital, San Francisco, Calif.
Marin General Hospital, San Francisco, Calif.
Mount Zion Hospital and Medical Center, San Francisco, Calif.
Presbyterian Hospital, San Francisco, Calif.
Samuel Merritt Hospital, San Francisco, Calif.
San Francisco General Hospital, Calif.
U. S. Public Health Service Hospital, San Francisco, Calif.
University of California Hospitals, San Francisco, Calif.

Bridgeport Hospital, Bridgeport, Conn.
Middlesex Memorial Hospital, Middletown, Conn.
Norwalk Hospital, Norwalk, Conn.
District of Columbia General Hospital, D. C.
Doctor's Hospital, D. C.
Georgetown University Hospital, D. C.
Morris Cafritz Memorial Hospital, D. C.
St. Elizabeth's Hospital, D. C.
Oscar B. Huriter Memorial Laboratory, Washington, D. C.
Sibley Memorial Hospital, D. C.
Veterans Administration Hospital, D. C.
Walter Reed General Hospital, D. C.
Washington Hospital Center, D. C.
St. Francis Hospital, Miami Beach, Florida
Doctor's Hospital, Miami, Fla.
Mercy Hospital, Miami, Fla.
Miami Heart Institute, Miami, Fla.
North Miami General Hospital, Fla.
North Shore Hospital, Miami, Fla.
South Miami Hospital, Fla.
Victoria Hospital, Miami, Florida
Baptist Memorial Hospital, Jacksonville, Fla.
Orange Memorial Hospital, Orlando, Fla.
Lakeland General Hospital, Lakeland, Fla.
Winter Haven Hospital, Winter Haven, Fla.
Crawford W. Long Memorial Hospital of Emory University, Atlan
Georgia Baptist Hospital, Atlanta, GA
Grady Memorial Hospital, Atlanta Ga
South Fulton Hospital, Atlanta, Georgia
Warren A. Candler Hospital, Savannah, GA
Hilo Hospital, Hilo, Hawaii
St. Francis Hospital, Honolulu, Hawaii
U. S. Army Tripler General Hospital, Honolulu, Hawaii

Alton Memorial Hospital, Alton, Illinois
Burnham City Hospital, Champaign, Ill.
American Hospital of Chicago, Ill.
Augustana Hospital, Chicago, Ill
Northwestern Memorial Hospital, Chicago, Ill.
Columbus Hospital, Chicago, Ill.
Cook County Hospital, Chicago, Ill.
Franklin Boulevard Community Hospital, Chicago, Ill.
Grant Hospital of Chicago, Ill.
Holy Cross Hospital, Chicago, Ill.
Illinois Central Hospital, Chicago
Illinois Masonic Medical Center, Chicago
Jackson Park Hospital, Chicago, Ill.
Louis A. Weiss Memorial Hospital, Chicago, Ill.
Mercy Hospital, Chicago, Ill.
Michael Reese Hospital and Medical Center, Chicago, Ill.
Northwest Hospital, Chicago, Ill.
Presbyterian, St. Luke's Hospital, Chicago, Ill.
Provident Hospital and Training School, Chicago, Ill.
Ravenswood Hospital, Chicago, Ill.
St. Elizabeth's Hospital, Chicago, Ill.
St. Joseph Hospital, Chicago, Ill.
Swedish Covenant Hospital, Chicago, Ill.
So. Chicago Community Hospital, Ill.
University of Chicago Hospitals and Clinics, Chicago, Ill.
University of Illinois Research & Educational Hospitals, Chicago, Ill.
Veterans Administration Research Hospital, Chicago, Ill.
Veterans Administration West Side Hospital, Chicago, Ill.
St. Francis Hospital, Evanston, Ill.
Riverside Hospital, Kankakee, Ill.
Pekin Memorial Hospital, Pekin, Ill.
Swedish-American Hospital, Rockford, Ill.
Carle Memorial Hospital, Urbana, Ill.
Hancock County Memorial Hospital, Greenfield, Indiana
St. Elizabeth Hospital, Lafayette, Ind.
Reid Memorial Hospital, Richmond, Ind.
St. Luke's Methodist Hospital, Cedar Rapids, Iowa
St. Anthony Hospital, Dodge City, Kansas
Providence Hospital, Kansas City, Kansas
John N. Norton Memorial Infirmary, Louisville, Kentucky
Williamson Appalachian Regional Hospital, So. Williamson, Kentucky
Hotel Dieu Sisters' Hospital, New Orleans, Louisiana
Mercy Hospital, New Orleans, LA
Methodist Hospital, New Orleans, LA
Ochsner Foundation Hospital, New Orleans, LA
Southern Baptist Hospital, New Orleans, LA
Tuoro Infirmary, New Orleans, LA
U. S. Public Health Service Hospital, New Orleans, LA
Veterans Administration Hospital, New Orleans, LA
Maine Medical Center, Portland, Maine
Thayer Hospital, Waterville, Maine
North Charles General Hospital, Baltimore Maryland
St. Agnes Hospital of the City of Baltimore, Md.
St. Joseph Hospital, Baltimore, MD
Sinai Hospital of Baltimore, MD
University of Maryland Hospital, Baltimore, MD
Clinical Center, National Institutes of Health, Bethesda, MD
U. S. Air Force Hospital, Camp Springs, MD
Kimbrough Army Hospital, Fort George G. Meade, MD
Frederick Memorial Hospital, Frederick, MD
Beverly Hospital, Beverly, Mass.
Carney Memorial Hospital, Boston, MA
Children's Hospital Medical Center, Boston, MA
Faulkner Hospital, Boston, MA
Massachusetts General Hospital, Boston, MA
Mount Auburn Hospital, Boston, MA
New England Deaconess Hospital, Boston, MA
Norwood Hospital, Norwood, Mass.

St. Elizabeth's Hospital, Boston, MA
New England Medical Center, Boston, MA
Veterans Administration Hospital, Boston, MA
Cardinal Cushing General Hospital, Brockton, MA
St. Anne's Hospital, Fall River, MA
Providence Hospital, Holyoke, MA
Framingham Union Hospital, Framingham, MA
St. Joseph's Hospital, Lowell, MA
Bon Secours Hospital, Methuen, MA
North Adams Hospital, N. Adams, MA
St. Luke's Hospital, Pittsfield, MA
Mercy Hospital, Springfield, MA
New England Sanitarium & Hospital, Stoneham, MA
Taunton State Hospital, Taunton, MA
St. Vincent Hospital, Worcester, M
Harper Hospital, Detroit, Mich.
Henry Ford Hospital, Detroit, Mich.
Sinai Hospital of Detroit, Mich.
Hurley Hospital, Flint, Mich.
Midland Hospital, Midland, Mich.
Muskegan General Hospital, Muskegan, Mich.
Bethesda Lutheran Hospital, Minneapolis-St. Paul, Minn.
Charles T. Miller Hospital, Minn. St. Paul, Minn.
Fairview Hospital, Minneapolis-St. Paul, Minn.
Lutheran Deaconess Home & Hospital, Minneapolis-St. Paul, Minn.
Midway Hospital, Minn.
Mount Sinai Hospital, Minn.
North Memorial Hospital, Minn.
Northwestern Hospital of Minneapolis, Minn.
St. John's Hospital, Minn.
St. Luke's Hospital, Minn.
St. Mary's Hospital, Minn.
Baptist Memorial Hospital, Kansas City, Missouri
Kansas City General & Medical Center, Missouri
St. Mary's Hospital, Kansas City, MO
Veterans Administration Hospital, Kansas City, MO
St. Louis City Hospital, MO
Daconess Hospital, St. Louis, MO
Homer G. Phillips Hospital, St. Louis, MO
Lutheran Hospital, St. Louis, MO
Mallinckrodt Institute, St. Louis, MO
Missouri Baptist Hospital, St. Louis, MO
St. John's Mercy Hospital, St. Louis, MO
St. Louis University Hospital, St. Louis, MO
St. Luke's Hospital, St. Louis, MO
St. John's Hospital, Springfield, MO
St. James Community, Hospital, Butte, Montana
Columbus Hospital, Great Falls, Montana
St. Patrick Hospital, Missoula, Montana
St. Elizabeth Hospital, Lincoln, Nebraska
Orange Memorial Hospital Unit, Orange, N. J.
Our Lady of Lourdes Memorial Hospital, Binghamton, N. Y.
Veterans Administration Hospital, Buffalo, N.Y.
Tompkins County Hospital, Ithaca, N. Y.
Mt. Vernon Hospital, Mt. Vernon, N. Y.
Beth Israel Hospital, New York, N.Y.
French Hospital, New York, N. Y.
Jewish Memorial Hospital, New York, N. Y.
Lenox Hill Hospital, New York, N. Y.
New York Medical College - Flower & Fifth Ave., Hospitals, New York, N.
Presbyterian Hospital in the City of New York, N. Y.
St. Vincent's Hospital & Medical Center of New York, N. Y.
Nathan B. Van Etten Tuberculosis Hospital, New York, N. Y.
Veterans Administration Hospital, New York, N. Y.

Maimonides Hospital of Brooklyn, N. Y.
Mt. Sinai Hospital, New York, N. Y.
U. S. Public Health Service Hospital, New York, N.Y.
Willowbrook State School, New York, N. Y.
St. Clare's Hospital of Schenectady, N. Y.
Highland Hospital, Rochester, N.Y.
St. John's Riverside Hospital, Yonkers, N.Y.
Charlotte Memorial Hospital, Charlotte, N.C.
Duke University Medical School, Durham, N.C.
Rex Hospital, Raleigh, N.C.
St. Alexius Hospital, Bismarck, N.D.
St. Joseph's Hospital, Minot, N.C.
Akron City Hospital, Akron, Ohio
Mercy Hospital of Canton, Canton, Ohio
Cleveland Clinic Hospital, Cleveland, Ohio
Lakewood Hospital, Cleveland, Ohio
Mount Sinai Hospital of Cleveland, Cleveland, Ohio
St. Vincent Charity Hospital, Cleveland, Ohio
Suburban Community Hospital, Cleveland, Ohio
University Hospitals of Cleveland, Ohio
Veterans Administration Hospital, Cleveland, Ohio
Woman's Hospital, Cleveland, Ohio
Riverside Methodist Hospital, Columbus, Ohio
Charles F. Kettering Memorial Hospital, Kettering, Ohio
Good Samaritan Hospital, Sandusky, Ohio
Detmer Hospital, Troy, Ohio
Presbyterian Hospital, Oklahoma City, Okla.
St. Francis Hospital, Tulsa, Okla.
Good Samaritan Hospital & Medical Center, Portland, Oregon
Mercy Hospital, Altoona, PA
Abington Memorial Hospital, Abington, PA
Bradford Hospital, Bradford, PA
Delaware County Memorial Hospital, Drexel Hill, PA
Lancaster General Hospital, Lancaster, PA
Citizens General Hospital, New Kensington, PA
Oil City Hospital, Oil City, PA
Albert Einstein Medical Center (Northern Division) Philadelphia, PA
American Oncologic Hospital (Cancer and Allied Diseases) Philadelphia, PA
University of Pennsylvania Hospital, Philadelphia, PA
Jefferson Medical College Hospital, Philadelphia, PA
Lankenau Hospital, Philadelphia, PA
Episcopal Hospital, Philadelphia, PA
Misericordia Hospital, Philadelphia, PA
Northeastern Hospital of Philadelphia, PA
Pennsylvania Hospital, Philadelphia, PA
Philadelphia General Hospital, PA
Veterans Administration Hospital, Philadelphia, PA
Allegheny General Hospital, Pittsburgh, PA
Somerset Community Hospital, Pa
Roger Williams General Hospital, Providence, R.I.
Veterans Administration Hospital, Providence, R.I.
John E. Fogarty Memorial Hospital, Woonsocket, R.I.
Sioux Valley Hospital, Sioux Falls, S.D.
East Tennessee Baptist Hospital, Knoxville, Tenn.
St. Mary's Memorial Hospital, Knoxville, Tenn.
Veterans Administration Hospital, Memphis, Tenn.
Vanderbilt University Hospital, Nashville, Tenn.
Collin Memorial Hospital, Dallas, Texas
Methodist Hospital of Dallas, TX
Parkland Memorial Hospital-Dallas County Hospital District, Texas
Presbyterian Hospital of Dallas, Texas
St. Paul Hospital, Dallas, Texas
Veterans Administration Hospital, Dallas, TX
Fort Worth Radiation Center, Fort Worth, TX

Harris Hospital, Fort Worth, Texas
St. Joseph Hospital, Fort Worth, TX
Ben Taub General Hospital, Houston, TX
University of Texas M. D. Anderson Hospital, Houston, TX
Baptist Memorial Hospital, San Antonio, TX
Wilford Hall, U. S. Air Force Base Hospital, San Antonio, TX
Holy Cross Hospital, Salt Lake City, Utah
DePaul Hospital, Norfolk, Virginia
King County Hospital, Seattle, Washington
Northgate General Hospital, Seattle, Wash.
Northwest Hospital, Seattle, Washington
Providence Hospital, Seattle, Wash.
St. Frances Xavier Cabrini Hospital, Seattle, Wash.
Swedish Hospital Medical Center, Seattle, Wash.
University Hospital, Seattle, Wash.
Veterans Administration Hospital, Seattle, Wash.
Virginia Mason Hospital, Seattle, Wash.
Veterans Administration Hospital, Huntington, W. Virginia
Wheeling Hospital, Wheeling, West Virginia
Sacred Heart Hospital, Eau Claire, Wisconsin
Holy Family Hospital, Manitowoc, Wisc.
Sheboygan Memorial Hospital, Sheboygan, Wisc.
Memorial Hospital of Natrona County, Casper, Wyoming

OTHERS INVOLVED IN DEVELOPMENT OF PRODUCTS

1. Thirty-three students from four community colleges
2. Regional Medical Program, Greater Delaware Valley, Wynnewood, Pennsylvani
3. Thirty-five people from nine Professional Societies
    (1) American College of Radiology
    (2) American Registry of Radiologic Technologists
    (3) The American Society of Clinical Pathologists
    (4) American Society of Medical Technologists
    (5) Atomic Energy Commission
    (6) Society of Nuclear Medicine
    (7) American Nuclear Societies
    (8) American Society of Radiologic Technologists
    (9) Society of Nuclear Medicine Technologists

IV.

UNIVERSITIES, SCHOOLS, HOSPITALS, AND OTHERS INVOLVED IN TESTING OF NMT PROJECT PRODUCTS

UNIVERSITIES INVOLVED IN TESTING OF PRODUCTS

University of Kentucky, Lexington, Ky.
Wake Forest University, Winston-Salem, N.C.
Duke Unervisity, Durham, N.C.
University of Alabama, Birmingham, Ala.
New York University Hospital, Bronx, N.Y..
Columbia College of Physicians & Surgeons, New York, N.Y.
Long Island University, Long Island, N.Y.
University of Oregon, Portlana, Oregon
University of Vermont, Burlington, Vt.
University of California, Davis, Calif.
University of Omaha, Omaha, Neb.
Johns Hopkins University, Baltimore, MD
Baylor University, Houston, Texas
Temple University, Philadelphia, Penna.
Vanderbilt University, Nashville, Tenn.
Massachusetts Institute of Technology, Cambridge, Mass.
Harvard University, Cambridge, Mass.
University of Colorado, Denver, Colo.
Nova University, Ft. Lauderdale, Fla.
Rutgers University, New Brunswick, N.J.
University of Missouri, Columbia, MO
University of Texas, Galveston, Texas
University of Southern California, Los Angeles, Calif.
University of Nevada, Las Vegas, Nev.
Yale University, New Haven, Conn.
State University of New York, Brooklyn, N.Y.
University of Virginia, Charlottsville, Va.
Oak Ridge Associated Universities, Oak Ridge, Tenn.
City Colleges of Chicago, Chicago, Illinois

POST-SECONDARY SCHOOLS INVOLVED IN TESTING OF PRODUCTS

Montgomery Community College, Takoma Park, Maryland
Essex Community College, Baltimore, Maryland
Houston Community College, Houston, Texas
Texas State Technical Institute, Waco, Texas
Penn. Jr. College of Medical Arts, Harrisburg, PA.
Nuclear Medicine Institute, Cleveland, Ohio
Hillsborough Community College, Tampa, Florida
Denver Community College, Denver, Colorado
Midlands Technical Institute, Midlands, S. C.
Central Virginia Community College, Lynchburg, VA
Ferris State College, Big Rapids, Michigan
Grossmont College, El Cajon, Calif.
Forrest Park Community College, St. Louis, MO.
Tulsa Junior College, Tulsa, Oklahoma
Utah Technical College, Salt Lake City, Utah
Los Angeles Valley College, Van Nuys, Calif.
Spokane Community College, Spokane, Washington
Suburban-Hennepin County Vocational Technical School, Minneapolis, Minn.
Massachusetts Bay Community College, Watertown, Mass.
Bergon Community College, Paramus, N. J.
Middlesex County College, Edison, N. J.
Washington Technical Institute, Washington, D. C.
Montgomery College, Tacoma Park, Maryland
Central Piedmont Community College, Charlotte, N.C.
Greenville Technical Institute, Greenville, S.C.
Triton College, River Grove, Illinois

Hospitals Involved in Testing of Products

University of Colorado Medical Center, Denver, Colo.
South Carolina Baptist Hospital, Columbia, S.C.
Milwaukee County General Hospital, Milwaukee, Wis.
Marion General Hospital, Marion, Ind.
VA Hospital, Allen Park, Mich.
Mt. Carmel Mercy Hospital, Detroit, Mich.
Hockley Hospital, Muskegon, Mich.
Women's General Hospital, Cleveland, Oh.
Ohio State University Hospital, Columbus, Oh.
Martin Memorial Hospital, Mt. Vernon, Oh.
VA Hospital, Lexington, Ky.
Duke University Medical Center, Durham, N.C.
New York Hospital
Northwestern Memorial Hospital, Chicago, Ill.
VA Hospital, Los Angeles, Cal.
Cincinnati General Hospital, Cincinnati, Oh.
Mt. Zion Hospital and Medical Center, San Francisco, Cal.
University of California Hospital, Davis, Cal.
Oscar B. Junter Memorial Laboratory, Washington, DC
Sinai Hospital, Baltimore, Md.
Johns Hopkins Hospital, Baltimore, Md.
National Naval Hospital, Bethesda, Md.
National Institute of Health Clinic, Bethesda, Md.
VA Hospital, Houston, Tx
Harrisburg Hospital, Harrisburg, Pa.
Abington Memorial Hospital, Abington, Pa.
Tampa General Hospital, Tampa, Fla.
Massachusetts General Hospital, Boston, Mass.
Peter Bent Brigham, Boston, Mass.
Boston City Hospital, Boston, Mass.
Harvard University Health Service Clinic, Cambridge, Mass.
Suburban Community Hospital, Cleveland, Oh.
St. Vincent's Charity Hospital, Cleveland, Oh.
VA Hospital, Cleveland, Oh.
St. Luke's Hospital, Milwaukee, Wis.
University of Kansas Medical Center, Kansas City, Kan.
University of Minnesota, Minneapolis, Minn.
St. Mary's Hospital, Minneapolis, Minn.
St. John's Hospital, St. Paul, Minn.
North Memorial Hospital, Minneapolis, Minn.
Research Hospital and Medical Center, Kansas City, Mo.
Menorabi Medical Center, Kansas City, Mo.
St. Luke's Hospital, Kansas City, Mo.
Mallinkrodt Institute of Radiology, St. Louis, Mo.
Hamer G. Phillips Hospital, St. Louis, Mo.

St. Mary's Hospital, Kansas City, Mo.
Missouri Baptist Hospital, St. Louis, Mo.
Deaconess Hospital, St. Louis, Mo.
St. Louis City Hospital, St. Louis, Mo.
St. John's Mercy Hospital, St. Louis, Mo.
Sioux Varley Hospital, Sioux Falls, S.D.
St. Vincent's Infirmary, Little Rock, Ark.
So. Baptist Hospital, New Orleans, La.
VA Hospital, New Orleans, La.
M. D. Anderson Hospital, Houston, Tx.
Scott and White Memorial Hospital, Temple, Tx.
St. Joseph's Hospital, Ft. Worth, Tx.
St. Paul's Hospital, Dallas, Tx.
Harris Hospital, Ft. Worth, Tx.
Methodist Hospital, Dallas, Tx.
Pinrose, Hospital, Colorado Springs, Colo.
FitzSimmons General Hospital, Denver Colo.
Swedish Hospital, Englewood, Colo.
Billings Deaconess Hospital, Billings, Mont.
Tucson, General Hospital, Tucson, Ariz.
Good Samaritan Hospital, Phoenix, Ariz.
St. Joseph's Hospital, Bakersfield, Ca.
Inter -Community Hospital, Covina, Ca.
Loma Linda University Hospital, Loma Linda, Ca.
Orange County Medical Center, Orange, Ca.
St. John's Hospital, Oxnard, Ca.
VA Hospital, Palo Alto, Ca.
Roseville Community Hospital
Doctor's Hospital, San Diego, Ca.
Presbyterian Intercommunity Hospital, Whittier, Ca.
St. Mary's Long Beach Hospital, Long Beach, Ca.
Cedars-Sinai Medical Center, Los Angeles, Ca.
HolyCross Hospital, San Fernando, Ca.
Presbyterian Hospital and Medical Center, San Francisco, Ca.
Samuel Merritt Hospital, Oakland, Ca.
L.A. County Hospital, Los Angeles, Ca.
University Hospital, Seattle, Wa.
The Mason Clinic, Seattle, Wa.
NY Polyclinic Medical School and Hospital, New York, NY
North Shore Hospital, Manhasset, NY
St. Vincent's Hospital and Medical Center, New York, NY
Sloan-Kettering Cancer Center, New York, NY
Nathan B. Van Etten TB Hospital, Bronx, NY
Mt. Sinai Hospital, New York, NY
Lenox Hill Hospital, New York, NY
Jewish Memorial Hospital, New York, NY
Homestead Hospital, Homestead, Pa.
Pennsylvania Hospital, Philadelphia, Pa.
Misericordia Hospital, Philadelphia, Pa.
Graduate Hospital, University of Pa., Philadelphia, Pa.
Walter Reed General Hospital, Washington, DC

George Washington University Medical Center, Washington, DC
Washington Hospital Center, Washington, DC
Georgetown University Hospital, Washington, DC
VA Hospital, Washington, DC
St. Elizabeth's Hospital Washington, DC
University of Kentucky Medical Center, Lexington, Ky.
Church Home and Hospital, Baltimore, Md.
St. Agnes Hospital, Baltimore, Md.
St. Joseph Hospital, Baltimore, Md.
Rex Hospital, Raleigh, NC
Yale New Haven Medical Center, New Haven, Conn.
Mercy Hospital, Portland, Me.
Augusta General Hospital, Augusta, Me.
Union Hospital, Fall River, Ma.
Newton-Wellesley Hospital, Newton Lower Falls, Ma.
Salem Hospital, Salem, Ma.
Wesson Memorial Hospital, Springfield, Ma.
Winchester Hospital, Winchester, Ma.
St. Elizabeth's Hospital, Brighton, Ma.
Mt. Auburn Hospital, Cambridge, Ma.
Lahey Clinic Foundation, Boston, Ma.
Mary Hitchcock Memorial Hospital, Hanover, NH
Rhode Island Hospital, Providence, RI
Atlantic City Hospital, Atlantic City, NJ
Jersey Shore Medical Center, Neptune, NJ
Hospital Center at Orange, Orange, NJ
St. Mary's Hospital, Passaic, NJ
St. Joseph's Hospital, Paterson, NJ
Riverview Hospital, Bred Bank, NJ
Overlook Hospital, Summit, NJ
St. Peter's Hospital, Albany, NY
Long Island Jewish-Hillside Medical Center, New Hyde Park, NY
University of Virginia Hospital, Charlottesville, Va.
Roanoke Memorial Hospital, Roanoke, Va.
Baptist Medical Center, Birmingham, Ala.
University of Alabama Medical Center Birmingham
Boca Raton Community Hospital,Boca Raton, Fla.
Mercy Hospital, Miami, Fla.
Osteopathic General Hospital, N. Miami Beach, Fla.
University Community Hospital, Tampa, Fla.
St. Mary's Hospital, W. Palm Beach, Fla.
Jackson Memorial Hospital, Miami, Fla.
North Shore Hospital, Miami, Fla.
Victoria Hospital, Miami, Fla.
Miami Heart Institute, Miami Beach, Fla.
Mt. Sinai Hospital, Miami Beach, Fla.
St. Francis Hospital, Miami Beach, Fla.
Good Samaritan Hospital, W. Palm Beach, Fla.
Dekalb General Hospital, Decatur, Georgia
VA Hospital, Atlanta, Ge.
Emory University Hospital, Atlanta, Ge.

Grady Memorial Hospital, Atlanta, Ge.
University of Missippi Medical Center, Jackson, Miss.
Memphis Hospital, Tenn.
Baptist Memorial Hospital, Memphis, Tenn.
Michael Reese Hospital, Chicago, Ill.
Evanston Hospital, Ill.
MacNeal Memorial Hospital, Nerwyn, Ill.
VA Hospital Hines, Ill.
University Chicago Hospital, Chicago, Ill.
Cook County Hospital, Chicago, Ill.
Jackson Park, Hospital, Chicago, Ill.
University of Illinois Research and Education Hospital, Chicago, Ill.
Holy Cross Hospital, Chicago, Ill.

Businesses and Industries Involved in Testing of Products

Microbiological Sciences, Inc., New York, NY
Hum RRO, El Paso, Tx
Hycel Corporation, Houston, Tx
Western New York Nuclear Research Center, Buffalo, NY

Others Involved in Testing of Products

Federal Regional Medical Programs

Michigan R.M.P., Detroit
Northeast Ohio R.M.P., Cleveland
Northlands R.M.P., Minn.
Missouri R.M.P., Columbus, Mo.
Arkansas R.M.P., Little Rock, Ark.
Oklahoma R.M.P., Oklahoma City, Okla.
Texas R.M.P., Austin, Tx
*Regional Research Prog. (U.S.O.E.), San Francisco, Ca.
W. Virginia R.M.P. Morgantown, W. Va.

Northern New England R.M.P., Burlington, Vt.
Regional Research Program, U.S.O.E./D.H.E.W., New York, NY
U.S. Atomic Energy Commission Division of Nuclear Education, Washington, DC
National Commission on Accrediting, Washington, DC
U.S. Civil Service Commission, Washington, DC
National Institute of Health, Bethesda, Md.
Regional Research Program, U.S.O.E./D.H.E.W., Atlanta, Ge.

Professional Organizations

American Medical Association, Allied Health Professions, Chicago, Il.
American Registry of Radiologic Technologists, Fraser, Mich.
American Society of Medical Technologists, Houston, Tx.
Health Manpower Council, Orinda, Ca.
Health Professions Council, San Francisco, Ca.
Georgia Hospital Association, Atlanta, Ge.
Health Careers Council, Chicago, Ill.
Louisiana Hospital Association, New Orleans, La.
Missouri Hospital Association, Jefferson City, Mo.
Nevada Hospital Association, Reno, Nev.
New York State Department of Health, Albany, NY
Regional Health Council/E. Appalachia, Morgantown, N.C.
Health Careers Council, Fargo, N.D.
American Society of Radiologic Technologists, Chicago, Ill.
American College of Radiology, Chicago, Ill.

Guidance Counselor, Springfield Trade High School, Springfield, Mass.
Coordinator, Voc.-Tech. Education, Division of Instruction, Public Schools of Newton, Mass.
Argonne National Library, Argonne, Ill.

V.

NMT INTERVIEW SCHEDULE AND QUESTIONNAIRE

TECHNICAL EDUCATION RESEARCH CENTER
142 MT. AUBURN STREET, CAMBRIDGE, MASSACHUSETTS 02138
AREA CODE 617 547-0430

NUCLEAR MEDICAL TECHNICIAN INTERVIEW SCHEDULE

Interview Number_______________

Interviewer____________________

Name of Hospital:

Name of department or division
where nuclear medicine is practiced:

Title of Interview Respondent:

Please indicate the title you use for the technician of nuclear medicine to whom your responses will apply:

Title of Technician:

About how many months of formal or on-the-job training beyond a high school education has this person received, or the average technician in your department received?

Months of training beyond high school:_____months

A Non-Profit Corporation

Card 01

NMT INTERVIEW

SECTION 1 The following questions concern tasks performed by the average technicians in your nuclear medical department.

1.1 Please circle in Column 1.1 how many times per month the following tasks are performed by your technicians.

"Not in Hospital" means that the task is not performed in your Department.
"0 times per month" means that the task is performed in your Department, but not by your average technician.
"1-3 times/month" is up to and including once a week.
"4-10 times/month" is weekly or semi-weekly.
"11+ times/month" is almost daily or more often.

1.2 Please circle in Column 1.2 the 5 or 6 most important which you would like to see your technicians be able to do better, or in addition to those he performs now.

	1.1					1.2
	Not in Hosp.	Techs now do				New or Additional Tasks
		0	1-3	4-10	11+	
Preparation						
17 1. Chemically prepare short-life isotopes:						
a) eluting the column	0	a	b	c	d	1
2. b) chemical preparation	0	a	b	c	d	2
3. c) sterilize	0	a	b	c	d	3
4. Calibrate isotopes against a standard	0	a	b	c	d	4
5. Prepare oral dose: measure from manufacturer's bottle	0	a	b	c	d	5
6. Prepare oral dose: mix, dilute to measure	0	a	b	c	d	6
7. Prepare injections: measure dose	0	a	b	c	d	7
8. Prepare injections: sterilize dose	0	a	b	c	d	8
9. Set up instruments for operation: a) in vivo studies	0	a	b	c	d	9
26 10. Set up instruments for operation: b) in vitro studies	0	a	b	c	d	10
Tests & Patients						
27 11. Administer isotopes to patients a) orally	0	a	b	c	d	11
12. Administer isotopes to patients b) by injection	0	a	b	c	d	12
13. Receive patients, explain tests to them and allay their fears	0	a	b	c	d	13
14. Position patient with respect to nuclear medical equipment	0	a	b	c	d	14
15. Superficial and specialized examination of patients	0	a	b	c	d	15
16. Attend to patient's comfort before and during scan	0	a	b	c	d	16
33 17. Understand operating room procedures	0	a	b	c	d	17

Card 01

	1.1					1.2
	Not in Hosp.	Techs now do				New or Additional Tasks
		0	1-3	4-10	11+	
Data Handling						
34 18. Abstract simple data from patient's chart	0	a	b	c	d	18
19. Make simple dose calculations for a) in vivo examinations	0	a	b	c	d	19
20. Make simple dose calculations for b) in vitro examinations	0	a	b	c	d	20
21. Make simple dose calculations for c) tracer examinations	0	a	b	c	d	21
22. Accumulate and process data for MD's interpretation	0	a	b	c	d	22
23. Examine scan test results for general credibility	0	a	b	c	d	23
40 24. Perform preliminary interpretations of observations for MD	0	a	b	c	d	24
Equipment						
41 25. Operate a rectilinear scanner for conventional scanning	0	a	b	c	d	25
26. Operate an autofluoroscope for static studies	0	a	b	c	d	26
27. Operate a scintillation camera for static studies	0	a	b	c	d	27
28. Operate an autofluoroscope for fast dynamic studies (under one minute scan)	0	a	b	c	d	28
29. Operate a scintillation camera for fast dynamic studies	0	a	b	c	d	29
30. Operate a scanner for slow dynamic studies (over one minute scan)	0	a	b	c	d	30
31. Operate an autofluoroscope for slow dynamic studies	0	a	b	c	d	31
32. Operate a scintillation camera for slow dynamic studies	0	a	b	c	d	32
33. Calibrate nuclear medical instruments	0	a	b	c	d	33
34. Check performance of existing and new nuclear medical instruments against manufacturer's specifications	0	a	b	c	d	34
35. Determine if a nuclear medical instrument is in need of major repair	0	a	b	c	d	35
36. Perform minor maintenance on nuclear medical instrument	0	a	b	c	d	36
37. Evaluate nuclear medical instruments from manufacturer's literature and specify and rank those instruments that satisfy the doctors' requirements	0	a	b	c	d	37
54 38. Advise doctors on the technicalities and procedures involved in operating a nuclear medical instrument	0	a	b	c	d	38
Safety						
55 39. Check monitoring instruments	0	a	b	c	d	39
40. Monitor personnel in compliance with hospital regulations	0	a	b	c	d	40
41. Monitor space in compliance with hospital regulations	0	a	b	c	d	41
42. Handle and store radioisotopes safely	0	a	b	c	d	42
43. Assay wet chemical solutions for activity and contaminants	0	a	b	c	d	43
60 44. Safely dispose of radioactive wastes	0	a	b	c	d	44
Clerical						
61 45. Handle secretarial work: appointments, type reports	0	a	b	c	d	45
46. Routinely check incoming equipment	0	a	b	c	d	46
47. Inventory and order radiopharmaceuticals and materials	0	a	b	c	d	47
64 48. Keep accounts of hospital licensing and isotope procurement	0	a	b	c	d	48
Others						
49.	0	a	b	c	d	49
50.	0	a	b	c	d	50
51.	0	a	b	c	d	51
52.	0	a	b	c	d	52

Card 02 - Card 03

1.3 Please indicate, using the code given below, why the five or six additional tasks you would like to see your technicians perform, which you circled in the task list 1.2, are not now being done by them.

Code:	Number from Task List 1.2	Reason why task performed now (Code)
1 Technician not trained for task	______ 66-67	______ 68
2 Technician not well trained enough	______ 69-70	______ 71
3 Shortage of staff	______ 72-73	______ 74
4 Facilities not yet available	______ 75-76	______ 77
5 Legal requirement or prohibition	______ 17-18	______ [illegible]
6 Other (please specify)	______ 20-21	______ [illegible]

[illegible] Card 03

1.4 Please indicate below which of the tasks you checked off in question 1.1 as now being performed by your technician, you think may become obsolete by 1972, because of: (give task number from 1.1)

(a) technological innovations 23 - 26

______ 23-24 ______ 25-26

(b) change in your department's areas of interest and work

______ ______ 27 - 30

(c) hospital organizational changes (e.g., combining old or creating new departments)

______ ______ 31 - 34

1.5 Please indicate what new tasks you think may be performed by your technicians in 1972, because of: (give task number from 1.1, or a phrase)

(a) technological innovation 35 - 38

______ ______

(b) change in department's areas of interest 39 - 42

______ ______

(c) hospital organizational changes (e.g., combining old or creating new departments)

______ ______ 43 - 46

1.6 What tasks, presently being carried out by you, would you turn over to your technicians, if they were better trained? (task number from 1.1, or a phrase)

______

______

______

NMT INTERVIEW

1.7 Please indicate, in the Table opposite, in the column marked 1.7, the number of major items of nuclear medical equipment which your Department now possesses (or has on order). Please place number of items on order in parentheses following number now possessed. Example: 2 (1)

1.8 If there are any other items of nuclear medical equipment located elsewhere in the hospital, which do not belong or are not controlled by your Department, please indicate, in the Table opposite, in the column marked 1.8, the number and types of the equipment.

1.9 For each kind of equipment which you have checked off which you now possess please indicate, in the table opposite, in the column marked 1.9, the average number of man-hours per week your technicians work with those pieces. Example: 3 Single Probe Scanners used by 4 technicians 1/2 time - 3 x 4 x 20 hrs/week - 240 man-hours.

1.10 If there are any items of equipment not operated by your nuclear medical technicians, please indicate, in column 1.10, below, using the following code, the reason for this:

Code: 1. Technicians not sufficiently well-trained to use or work with the equipment.
2. Too responsible an operation/test to be performed by a technician.
3. Could be done by a technician but you have a specialist to do it.
4. Other.

1.10		1.11
Item of equipment (Number from Table)	Code	Will be operated by technician by 1972

1.11 Please check in column 1.11, above, if any of the items of nuclear medical equipment which you indicated in 1.10 as not now being operated by technicians, will be operated by your technicians by 1972.

Cards 02 - 04

1.7 Equipment have now: no parentheses
(equipment on order: number in
parentheses) Example: 2 (1)

MAJOR ITEMS OF NUCLEAR MEDICAL EQUIPMENT	1.7 Equip. in your Dept.	1.8 Equip. elsewhere in Hosp.	1.9 Tech. man-hrs per/wk on Equip.	
1. Single Probe Scanner -- 3", 5", or 8"	47 - 48	49	50 - 52	47 - 52
2. Dual Probe Scanner				53 - 58
3. Autofluoroscope				59 - 64
4. Scintillation Camera				65 - 70
5. Whole Body Scanner (radiation distribution)				71 - 76
6. Whole Body Counter (total radiation level)			17 - 19	Begin Card 03
7. Manual Well System				20 - 25
8. Automatic Well System				26 - 31
9. Dose Assay Ionization Chamber				32 - 37
10. Monitoring Ionization Chamber				38 - 43
11. Single Probe Renal System				44 - 49
12. Dual Probe Renal System				50 - 55
13. Computer Applications of Scintillation Camera				56 - 61
14. Liquid Scintillation System				62 - 67
15. Orthodensitometer				68 - 73
16. Multichannel Gamma Ray Spectrometer				74 - 79
17. T-3 Type or T-4 Type Measurement System	17 18			Begin Card 04
18. Automatic or Semi-automatic Blood Volume Measurement Systems				23 - 28
19. Automatic Film Developing Facilities				29 - 34
20. Other:				
21. Other:				

NMT INTERVIEW

Equipment Repair and Maintenance:

1.12 How many service calls were made on all your nuclear medical equipment in the past year? ________

1.13 Approximately what percent of these repairs were done by personnel not from your hospital? ________

1.14 Approximately what percent of repairs were done by your hospital's equipment serviceman or maintenance people? ________

1.15 Approximately what percent of repairs were done by an NMT? ________

Total=100%

1.16 How many of the following are performed per month in your department?

1. Image or localization studies ________
2. Flow studies (e.g., brain blood flow) ________
3. Dilation studies (e.g., blood volume) ________
4. Absorption, Excretion tests (e.g., Schilling tests) ________
5. Rapid uptakes (e.g., renograms) ________
6. Slow uptakes (e.g., thyroid uptakes) ________
7. *In vitro* tests (e.g., T-3 tests) ________

1.17 Is radiotherapy performed in your nuclear medical unit?

Yes: Radioparmaceutical therapy____
Brachytherapy ____
Teletherapy ____
No:____

1.18 How many technicians in your nuclear medical unit are *principally* doing radiopharmaceutical therapy?

(None = 0) 0 1 2 3 4 5 6 7 8 __

Cards 04 - 05

NMT INTERVIEW

Section 2 The following questions concern the working conditions which are characteristic of those experienced by your nuclear medical technicians.

2.1 Please circle the annual salary range which you now pay your technician.

(circle one letter in each row)

Certification & years of experience	4,000-4,999	5,000-5,999	6,000-6,999	7,000-7,999	8,000-8,999	9,000-9,999	10,000-11,999	Over 12,000	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
1. non-certified and first year	a	b	c	d	e	f	g	h	75
2. non-certified and second year	a	b	c	d	e	f	g	h	76
3. non-certified and fifth year	a	b	c	d	e	f	g	h	77
4. certified and first year	a	b	c	d	e	f	g	h	78
5. certified and second year	a	b	c	d	e	f	g	h	79
6. certified and fifth year	a	b	c	d	e	f	g	h	80

Begin Card 05

2.2 Do you prefer males or females in the role of a nuclear medical technician? 17

(1) ____ males (2) ____ females (3) ____ no preference

2.3 Does your NMT technician work 18

(1) ____ primarily alone

(2) ____ primarily with one other technician

(3) ____ with two other technicians

(4) ____ with more than two other technicians

Card 05

NMT INTERVIEW

2.4 In the process of performing his tasks, the technician interacts with numerous people, in and out of the hospital. For each of the following categories, please indicate the frequency of the interaction by writing the appropriate letter from this scale:

(1) A = frequently
(2) B = seldom, but the interaction is very important
(3) C = seldom, and the interaction is relatively unimportant
(4) D = never or hardly ever
Blank = don't know

function of interaction to-from-		doctors	nurses	other hospital technicians	hospital general administrative staff	maintenance personnel	eqpt. mnfrs., drug suppliers	departmental administrative staff	others (please specify)	PERSONS INSIDE HOSPITAL E.G. MD'S NURSES	PERSONS OUTSIDE HOSPITAL E.G. MAINTENANCE, COMMERCIAL PERSONS	
1. read reports	from	19	20	21	22	23	24	25				19-25
2. write reports	to	27						33				27-33
3. fill out forms	for	35						41				35-41
4. receive written instructions and/or information	from	43						49				43-49
5. give written instructions and/or information	to	51						57				51-57
6. receive verbal instructions and/or information	from	59						65				59-65
7. give verbal instructions and/or information	to	67						73				67-73

2.5 Can you give us some samples of the forms (administrative and specialized) the NMT has to work with?

2.6 The NMT technicians in your department report directly to: 75
(a) M.D.'s____ (1)
(b) a Head Nuclear Medical Technician____ (2)
(c) a Head Technician____ (3) Please specify type____________________
(d) other____ (4) Please specify______________________________

Cards 05-06

Section 3

The following questions concern the hiring of Nuclear Medical Technicians and your projected manpower needs for these technicians.

If some, or all of your technicians work only part-time, please estimate the fraction of their working week devoted to nuclear medicine tests/operations and give the total in terms of numbers of full-time technicians. (For example, if you have two part time technicians, each working half time, and a third technician working three-quarter time, then you would answer question 3.1 as one and three-quarters technicians.)

3.1 How many nuclear medical technicians did your Department have at the beginning of 1969?______ How many persons did this represent?______ 76-79

3.2 If you have several technicians working part time, and their total time is equivalent to one person's normal working time, is it valid for us to assume that your needs could be satisfied by one nuclear medical technician? 80

(1)__________yes (2)__________no

If no, please explain.

Begin Card 06

3.3 Is this number sufficient for your Department's current needs? 17

(1)__________yes (2)__________no

3.4 If your answer to 3.2 was no, please circle the importance of each of the following constraints which prevent your department from hiring more NMT technicians.

Possible constraints	Degree of importance great	some	slight	none	
1. lack of funds for salaries	1	2	3	4	18
2. lack of trained technicians	1	2	3	4	19
3. lack of manpower to train technician candidates	1	2	3	4	20
4. lack of supervisors for technicians	1	2	3	4	21
5. lack of nuclear medical equipment	1	2	3	4	22
6. other (please specify below)	1	2	3	4	

Cards 06-07

NMT INTERVIEW

3.5 Looking back over the past three years and also looking to the future, please answer, for each year, the following questions:

How many persons did you (or do you expect to):	1966	1967	1968	1969	1970	1971	1972	
(a) hire with some NMT training;	23-24/25-26	/	/	/	/	/	/	23-50
(b) hire with no NMT training, to be trained in your department.	/	/	/	/	/	/	/	51-78
(c) How many technicians left your department's employ?	17-18/19-20	/	/	/	▨	▨	▨	Begin Card 07 17-32
(d) Of the technicians who left your department, how many left the field of nuclear medicine?	/	/	/	/	▨	▨	▨	33-48

*For each box, answer as follows: number of people / number of equivalent full-time technician

Example: 5 people, all 1/2 time -

3.6 Please indicate below the most important reason(s) which you believe led to their leaving. 49

1. just want a change - or work, city, experiences ______
2. lack of opportunity to advance in position ______
3. inadequate salary schedule ______
4. lack of interest in the type of work ______
5. lack of competence to perform the tasks ______
6. interpersonal conflict ______
7. other (please specify) ______

Card 07

NMT INTERVIEW

3.7 Assume that to fill a position as Nuclear Medical Technician, you must choose among several candidates, all graduates of a high school who appear equal in basic intelligence. Please -

(a) establish a base salary for this position

(b) rank the following factors as you would value them in comparing the candidates (1 = most important)
RANK ONLY TOP FOUR (4)

(c) indicate the differential (amount in dollars plus or minus) from the base salary produced by each factor

Base salary for the position $__________ 50

Comparison factors: candidate has completed	Rank value	Salary diff. + or -
(a) no post-secondary training or experience	51	52
(b) two years of on-the-job training in hospital medical laboratories other than in radiation	53	54
(c) two years of on-the-job training in a nuclear medical department	55	56
(d) a two-year X-Ray technician program involving hospital experience over several semesters	57	58
(e) same as (d) plus six-month hospital internship program	59	60
(f) a two-year nuclear medical technician program involving hospital experience over several semesters	61	62
(g) same program as (f) plus six-month hospital internship program	63	64
(h) a registered nurse training program	65	66
(i) a four-year college degree program in biology/chemistry/physics	67	68
(j) four-year Medical Technologist Program including hospital experience over several semesters	69	70

Card 07

3.8 Do you see any parallels in rate of growth of the use and practice of nuclear medicine and some other, now more developed, specialty of medicine? (1)___ yes (2)___ no 71

if yes, what field of medicine ____________________

3.9 What do you see as the major factors which could slow or limit the growth of the use of nuclear medicine? ____________________

3.10 What do you see as the major factors which could speed the growth of the practice of nuclear medicine? ____________________

3.11 Please estimate how many nuclear medical technicians your Department will need in (a) 1975____ 72-75

(b) 1980____

3.12 Suppose that your reputation depended on your success in predicting the percentage of hospitals in the United States that will have nuclear medical operations (a) by 1975, (b) by 1980. What percentages would you predict for each? (Presently about 30% of all hospitals listed in the AHA guide have a radioisotope facility). Please circle the appropriate figure for each year.

% by 1975	20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100	76-77
% by 1980	20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100	78-79

Card 10

NMT INTERVIEW

Section 5

These questions pertain to the development and growth of your Department.

5.1 In which department did nuclear medical operations begin? 20

1. Department of Radiology____
2. Department of Pathology____
3. Nuclear Medicine was established____ as a separate department/ unit with its own rights.
4. Other (please specify) ________________________________

5.2 How long is it since nuclear medical tests/operations first started in your hospital? ____years 21-22

5.3 How many technicians did you have working in nuclear medicine at the end of the first year? (Count two half-time technicians as one technician, etc.) ________ 23-24

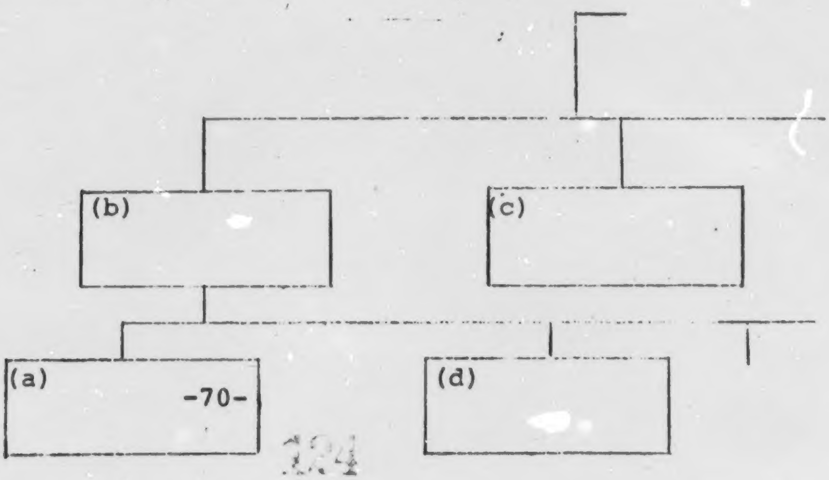
5.4 Are there any other nuclear medical tests/operations carried out elsewhere in the hospital, which are not under your Department's control? (1)______yes (2)______no 25

If so, please name Departments ______________________________

____

5.6 Please fill in the following organizational chart for your hospital. 26

1. Please locate and give the actual name of your Nuclear Medical Department in Block (a).
2. Please locate the Department/Unit/Division above the Nuclear Medical Department in Block (b).
3. If the Pathology or Radiology Departments are not mentioned above, how are they located in the organizational hierarchy in relation to the Nuclear Medical Department?



Card 08

NMT INTERVIEW

Section 4

Begin Card 08

These questions concern your present training program, and/or the kind of training programs, that you would like to see developed to train nuclear medical technicians.

Part A

4.1 Please check below, how your technicians are now trained. 17

(a) (1)_____informal hospital training program

(b) _____formal hospital training program (ARRT Curriculum (2)_____yes
(3)_____no

(c) (4)_____formal training program in collaboration with other hospitals

(d) (5)_____formal training program in collaboration with community college/technical institute

(e) (6)_____formal training program in collaboration with a university medical school

(f) (7)_____only hire trained or experienced technicians

If you checked (f), please skip to question 4.20, Part C

4.2 What is the length of your program? _____(weeks) (months) 18-19

4.3 Who teaches it? (1)_____M.D.'s (2)_____Specialists (3)_____Others 20

4.4 How many students/trainees were in this program last year? _____ 21-22

4.5 How many students/trainees graduated from this program during last year? _____ 23-24

4.6 How many students/trainees do you expect will graduate from the program during this year? _____ 25-26

4.7 What degree or certificate, if any, results from this program? 27
(1)_____none; title of degree/certificate_____________________(2)[illegible]

4.8 Are the trainees who complete this program eligible to take:

(a) American Registry of Radiologic Technologists Certification examination? (1)_____yes (2)_____no 28

(b) Registry of Medical Technologists? (1)_____yes (2)_____no 29

4.9 Does the length of the program depend on the previous background of the trainee? (1)_____yes (2)_____no 30

If yes, please explain briefly:

NMT INTERVIEW

4.10 Does the content or clinical training of the program depend on the previous background of the trainee? ______yes ______no

If yes, please explain briefly:

4.11 Please indicate the present number of trainees, and recent graduates from the program, having the following backgrounds.

	Recent Graduates		Trainees
	1967	1968	1969
1. X-Ray technician			
2. Medical Technologist			
3. Laboratory Assistant			
4. High School graduate			
5. Nurse			
6. College graduate in Science			
7. Other			
8. Don't know			

Part B

Please answer the following questions of the program you are now involved in, or that is now being developed, is a collaborative training program with other hospitals and/or educational institutions. IF IT IS NOT, PROCEED TO PART C, PAGE 17.

4.12 What kind of education program is involved:

Full-time educational program (regular intervals of in-hospital clinical work alternating with regular intervals of classroom instruction at the educational institution) without internship as part of total program; ______ 1.
Full-time cooperative educational program with following internship as part of total program; ______ 2.
Full-time non-cooperative educational program, with post-graduate internship; ______ 3.
Part-time school-based courses for full-time hospital employees now in a different medical field; ______ 4.
Part-time school-based courses designed for upgrading full-time hospital employees already in the field; ______ 5.
Other. ______ 6.

Cards 08 - 09

NMT INTERVIEW

4.13 How many months of the total program is spent in clinical or class work at a hospital?

(a) before graduation: class work ______ (weeks) (months) 75-76

clinical work ______ (weeks) (months) 77-78

(b) in a post-graduate internship program with a systematic educational design:

class work ______ (weeks) (months) 79-80

Begin Card 09

clinical work ______ (weeks) (months) 17-18

4.14 How many other hospitals and/or schools are collaborating in this program:

______ hospitals 19

______ schools 20

4.15 Please give in the Table below, the name(s) of the institution(s)/ hospital(s) involved in the program, and the distances and time to travel between your hospital and these other institution(s)/hospital(s).

Name of Institution	Location	Distance from your hospital in miles	Time to travel by public transportation
1.			
2.			
3.			

4.16 How many M.D.'s or specialists from your hospital are involved in this collaborative program?

(a) in teaching? ______ 21-22

(b) in advising on development? ______ 23-24

(c) in design and initiation? ______ 25-26

(d) in evaluation? ______ 27-28

4.17 Do you support the living costs of your staff while they receive training outside of your hospital? (1) ______ yes; (2) ______ no. 29

NMT INTERVIEW

4.18 Do you pay any of the tuition costs? $________total (not per person) tuition costs/year.

________% percentage paid by you

4.19 In the discussions both before and after you reached agreement to set up a collaborative program, which of the following factors apply and how important is each to you? Please circle the appropriate number in each case.

	Importance		
	great	some	little
(a) That you have control over the specialized content of the curriculum	1	2	3
(b) That the program include on-the-job experience over several semesters	1	2	3
(c) Same as (b) followed by an internship program in a nuclear medical department	1	2	3
(d) That specialized courses be taught by MD's	1	2	3
(e) That your Department be represented on an active advisory board to the educational program	1	2	3
(f) That the AMA or another professional association approve the curriculum. Please specify the professional association________	1	2	3
(g) Other			
(h) Other			

PLEASE PROCEED TO PART D, PAGE 18

Part C

PLEASE ANSWER THE FOLLOWING QUESTIONS IF YOU DID NOT ANSWER PART B. IF YOU ANSWERED PART B, PLEASE SKIP TO PART D, PAGE 18.

4.20 Would you consider establishing a collaborative nuclear medical training program with other institutions? _____yes _____no

If no, please very briefly give the reasons and then skip to Part D, question 4.30.

Card 09

NMT INTERVIEW

4.21 If your Department were considering establishing a collaborative educational program, please rank your preference for working with the following:

_____(a) Other hospitals only; 43

_____(b) Other hospitals and a University Medical School; 44

_____(c) University Medical School; 45

_____(d) Other hospitals and a Community College or Technical Institute; 46

_____(e) Community College or two-year Technical Institute; 47

_____(f) Other: 48

4.22 What kind of education program would you like to see? 49

_____1. full-time educational program (regular intervals of in-hospital clinical work alternating with regular intervals of classroom instruction at the educational institution) without internship as part of total program.

_____2. full-time program with following internship as part of total program.

_____3. full-time non-cooperative educational program, with post-graduate internship.

_____4. part-time school-based courses for full-time hospital employees now in a different medical field.

_____5. part-time school-based courses designed for upgrading full-time hospital employees already in the field.

_____6. other:

4.23 Assuming that the students entering the collaborative program are mainly high school graduates, what is the length of the formal training program that you would design, so that the graduate could assume responsibility for carrying out nuclear medical tests and operations in your Department? 5.

Formal training program length ___________ years.

4.24 How many months of the total program would be spent in clinical or class work at your hospital?

(a) before graduation: class work _________ (weeks) (months) 51-52

clinical work _________ (weeks) (months) 53-54

(b) in a post-graduate internship program with a systematic educational design:

class work _________ (weeks) (months) 55-56

clinical work _________ (weeks) (months) 57-58

Card 09

NMT INTERVIEW

4.25 Please give the names of the institutions/hospitals that you would prefer to collaborate with, the distances and time to travel between your hospital and the other institutions/hospitals, in the table below.

Name of Institution	Location	Distance from your hospital in miles	Time to travel by Public Transportation
1.			
2.			
3.			

4.26 Would you be willing to support the living costs of your staff while they received training outside of your hospital? (1)_____yes (2)_____no 59

4.27 Would you be willing to pay any of the tuition costs?

$_____total tuition costs/year 60-63

_____%paid by you 64-65

4.28 Which of the following factors would be important to you in setting up a collaborative program with your preferred choice. Please circle the appropriate number in each case.

	Importance great	some	little	
(a) That you have control over the specialized content of the curriculum.	1	2	3	66
(b) That the program include on-the-job experience over several semesters.	1	2	3	67
(c) Same as (b) but followed by an internship program in a nuclear medical department.	1	2	3	68
(d) That specialized courses be taught by MD's.	1	2	3	69
(e) That your Department be represented on an active advisory board to the educational program.	1	2	3	70
(f) That the AMA or another professional association approve the curriculum. Please specify the professional association____________	1	2	3	71
(g) Other:	1	2	3	
(f) Other:	1	2	3	

SKIP TO PART D, PAGE ~~18~~ 21, IF YOUR ANSWER TO 4.21 WAS d) OR e).

4.29 If your local community college or technical institute were to seek your help in setting up a two-year nuclear medical training program, would you:

(a) be willing to collaborate with them? _____yes _____no

(b) if no, would you employ their graduates? _____yes _____no

(c) if you are willing to collaborate with them, which of the following factors would apply and how important is each to you? Please circle the appropriate number in each case.

	Importance		
	great	some	little
(a) That you have control over the specialized content of the curriculum	1	2	3
(b) That the program include on-the-job experience over several semesters	1	2	3
(c) Same as (b) but followed by an internship program in a nuclear medical department	1	2	3
(d) That specialized courses be taught by MD's	1	2	3
(e) That your Department be represented on an active advisory board to the educational program	1	2	3
(f) That the AMA or another professional association approve the curriculum. Please specify the professional association_______________	1	2	3
(g) Other:	1	2	3
(h) Other:	1	2	3

NMT INTERVIEW

Part D

These questions concern instructional materials, instructional aids and lab kits which are used, or could be used, in nuclear medical technician training programs. Here is a list of some of the media employed.

Media Code No.	Media
1	Teacher's manuals and/or source books
2	Commercially published textbooks
3	Manufacturers' manuals
4	Programmed instruction booklets
5	Your own booklets
6	Overhead projector transparencies
7	Film
8	Film loops
9	Film strips
10	Student lab kits
11	Simulation laboratories
12	Other ______________________________

4.30 Please name the instructional materials, etc. which you use or believe that could be used for training nuclear medical technicians. Perhaps you have a syllabus or reading kit which you could give us.

Instructional Materials (Title and Author)	Media Code

4.31 How long ago were these materials updated? ______years
How often would you like to see them updated? ______years

4.32 Please name by topics, the new instructional materials, aids, etc. that you feel are most urgently needed for use in programs for training nuclear medical technicians. (Example: "Rapid uptake studies" 8)

Topics	Media Code

NMT INTERVIEW

Section 6

Is there any other information which you think could be important and useful to our study which we have not obtained through this questionnaire? If so, please comment below:

Remember!

Question 2.5: Can you give us samples of the forms (administration and specialized that NMT has to work with?

Section 4: Course syllabus and/or lists of materials.

VI.

PARTICIPANTS IN NMT

INTERACTIVE NETWORK

Composition of NMT Interactive Network
Participants by HEW Region
October, 1971

HEW Region	Educators/ Prof.Assoc.*	Industry	Technicians	Physicians/Physic.	TOTAL
I	12	6	21	20	59
II	14	13	46	35	108
III	48	2	31	31	112
IV	15	1	35	18	69
V	16	4	46	44	110
VI	3	3	23	31	60
VII	12	1	15	25	53
VIII	3	-	15	7	25
IX	5	4	50	29	88
X	3	-	10	8	21
CANADA	7	-	22	6	35
TOTAL	138	34	314	254	740

*Includes hospital administrators, colleges, universities, technical institutes, government and professional associations.

Professional Affiliations of NMT Interactive Network Participants *

Affiliated with community college	30%
Affiliated with university	27%
Affiliated with medical school	32%
Affiliated with hospital	65%

* Because some participants have more than one affiliation the total is more than 100%.

VII.

NMT PROJECT CONFERENCES AND WORKSHOPS

Conferences and Workshops sponsored by NMT Project

First TERC Conference on NMT Education,
Cambridge, Mass. (Dec., 1970)

Second TERC Conference on NMT Education,
Denver, Colorado (June, 1971)

Third TERC Conference on NMT Education,
Atlanta, Georgia (July, 1971)

Joint NMT/BMET Workshop on Career Development,
Cambridge, Massachusetts (Dec., 1971)

First Regional Workshop on Implementation of
an NMT Career Ladder, Philadelphia, Pa.
(Sept., 1971)

BS Degree Program Workshop,
Indianapolis, Indiana (Feb., 1972)

Second Regional Workshop on Implementation of
an NMT Career Ladder, Tampa, Florida
(June, 1972)

First Curriculum Guide Workshop,
Chicago, Illinois (April, 1972)

Second Curriculum Guide Workshop (in
conjunction with annual SNM meeting),
Boston, Massachusetts (July, 1973)

NMT Field Coordinators Workshop,
Cambridge, Massachusetts (Feb., 1974)

VIII.

ARTICLES AND PRESENTATIONS

BY

NMT PROJECT PERSONNEL

Articles, Presentations by NMT Project Staff Personnel

Bakke, Robert. "On the Development of Behavioral Objectives," presented to Symposium on Technology, Wentworth Institute, Boston, November, 1972.

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Heptonstall, Sonia. "Cooperative Education at the Post-Secondary Level: The Organization of Nuclear Medicine Technician Training Programs," presented in workshop session at Cooperative Education Conference (Tampa, Fla., 1971).

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Articles, Presentations (Continued)

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Smackey, Thelma. "On the Use of Enabling Objectives," presented to Symposium on Technology, Wentworth Institute, Boston, November, 1972.

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IX.

SAMPLE VTD LEARNING MODULE: "PRE-IMAGING CHECKLIST FOR THE GAMMA CAMERA"

TERC
Technical
Education
Research
Centers

Pre-Imaging Checklist
for the
Gamma Camera

A
LEARNING
MODULE

120-010

PREIMAGING CHECKLIST FOR THE GAMMA CAMERA

120-010

LEARNER ACTIVITY GUIDE

Preimaging Checklist For The Gamma Camera

Overview

The preimaging checklist specifies a series of tasks that must be performed as a prerequisite to obtaining a gamma camera image of satisfactory quality and whose characteristics meet departmental specifications.

Prerequisites

Before beginning this module, the student must have:

☐ demonstrated a knowledge of the types of gamma camera collimators;

☐ demonstrated knowledge of the nomenclature of the gamma camera;

☐ demonstrated a basic knowledge of the operational procedure of the gamma camera, including attaching collimators, and mounting image recording devices;

☐ observed a competent technician perform the entire operation.

Non-essential Knowledge:

- Knowledge of the electronics and mechanics of the gamma camera.

Objectives

Given a gamma camera, an assortment of collimators, specified image recording device(s), the student will set up the instrument for obtaining an image:

☐ carrying out in exact sequence the operations involved.

Equipment Required

☐ Gamma camera

☐ Collimators

☐ Selected image recording device(s)

☐ Radioactive source

Optional Reference

Operational manuals for Nuclear Chicago and other model gamma cameras.

Early, P. J., Razzak, M. A., and Sodee, D. B., *Textbook of Nuclear Medicine Technology*, St. Louis: The C. V. Mosby Company, 1969.

Technical Terms

Gamma camera
Collimator
Detector head
Cathode ray tube (CRT)
Scalers A and B
Image recording device
Display scope
Radioactive source
Reticule

CRITERION CHECKLIST

Preimaging Checklist For The Gamma Camera

S U

☐ ☐ 1. Selects and attaches appropriate collimators to the detector head.

☐ ☐ 2. Checks that CRT display is on NORMAL.

☐ ☐ 3. Checks that Detector Output is on FULL.

☐ ☐ 4. Checks that Display Control is on SCALAR A.

☐ ☐ 5. Checks that Photo Record is set to MANUAL.

☐ ☐ 6. Mounts image recording device(s) and checks that visual access to display scope is unobstructed.

☐ ☐ 7. Places a radioactive source an appropriate distance from Detector Head.

☐ ☐ 8. Pushes START button.

☐ ☐ 9. Focuses Scope(s) by turning up the intensity control and individually adjusting the FOCUS and ASTIGMATISM controls until the data appear in sharp focus.

☐ ☐ 10. Adjusts RETICULE ILLUMINATION control until it can "just" be seen.

☐ ☐ 11. Closes visual access.

☐ ☐ 12. Pushes the STOP button.

☐ ☐ 13. Returns the radioactive source to designated storage area.

PREIMAGING CHECKLIST FOR THE GAMMA CAMERA

Introduction

The preimaging checklist specifies a series of tasks that must be performed as a prerequisite to obtaining a gamma camera image of satisfactory quality and whose characteristics meet departmental specifications.

Since these specifications differ from one department to another, the emphasis of this module is on the process rather than any particular setting or values.

This module has been prepared using a Nuclear Chicago model gamma camera. Departments using other instruments should modify these procedures to comply with their instrument's operation.

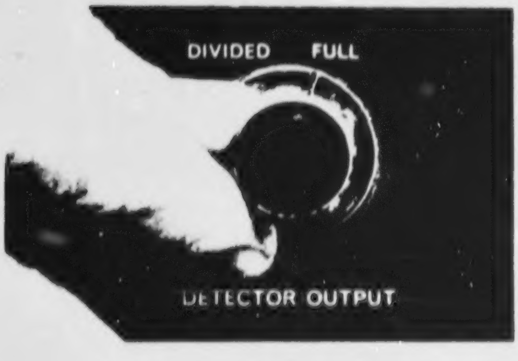
The photograph below shows the control panel of the gamma camera.

1. Select and attach the appropriate collimator to the detector head.

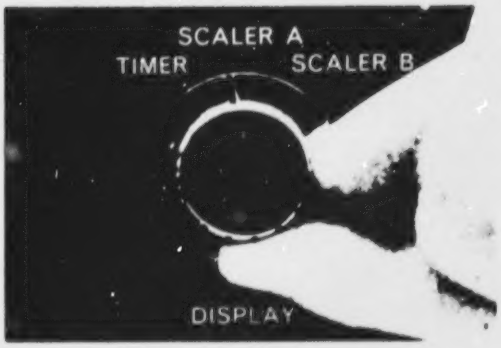
2. Check that the CRT DISPLAY control is set to NORMAL.

CRT DISPLAY
NORMAL
SPECTRUM

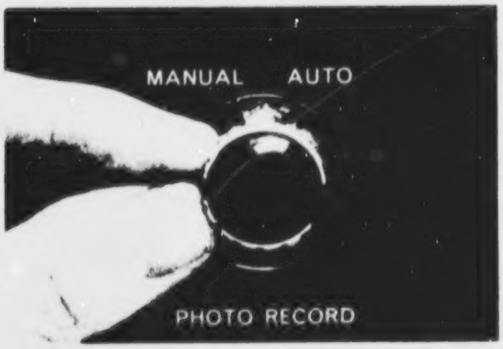
3. Check that the DETECTOR OUTPUT control is set to FULL.


DIVIDED
FULL
DETECTOR OUTPUT

4. Check that the DISPLAY control is set to SCALER A.

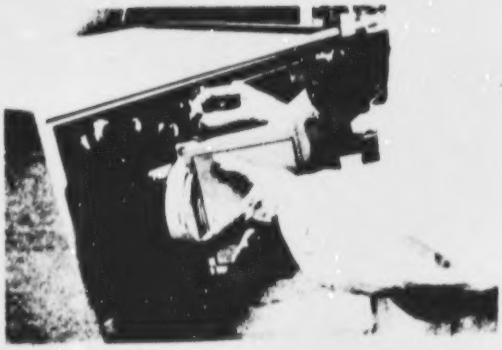

SCALER A
TIMER
SCALER B
DISPLAY

5. Check that the PHOTO RECORD control is set to MANUAL.

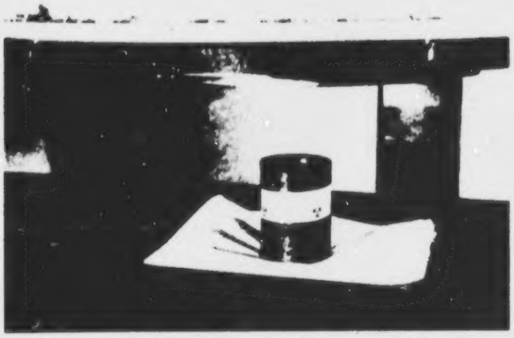

MANUAL
AUTO
PHOTO RECORD

6. Mount the image recording device(s) (e.g. - Polaroid Camera) on the display scope(s) (DISPLAY A and/or DISPLAY B) and check that visual access to the display scope is unobstructed (e.g. - open viewport if using Polaroid Camera.)

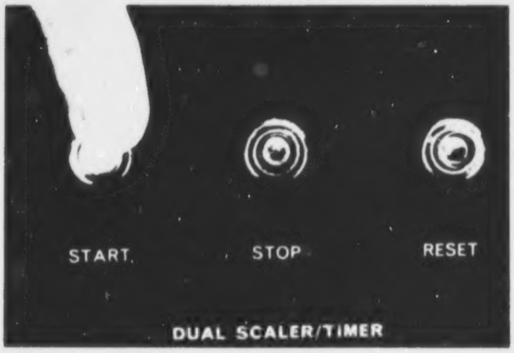
   NOTE: If using a Polaroid camera check that dark slide is in before opening viewport.



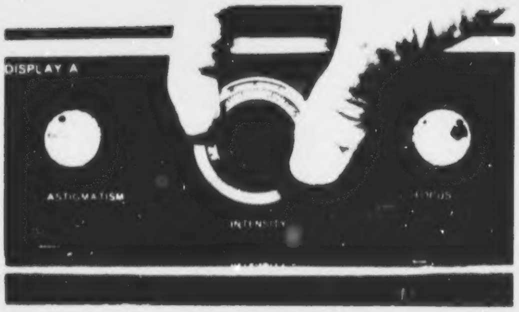
7. Center a radioactive source an appropriate distance from the detector head.



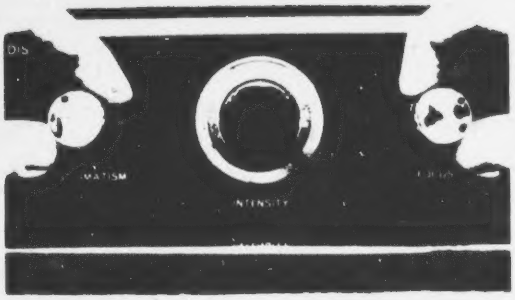
8. Start the instrument counting by pushing the START button.


START
STOP
RESET
DUAL SCALER/TIMER

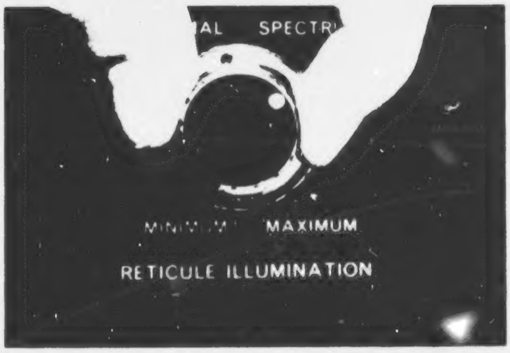
9. Focus Scope(s) A and/or B by turning up the INTENSITY control...


DISPLAY A
ASTIGMATISM
INTENSITY
FOCUS

...and then simultaneously adjusting the FOCUS and ASTIGMATISM controls on the display until the dots appear in sharp focus.

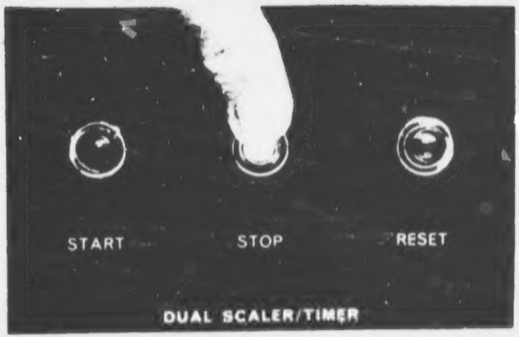

DIS
MATISM
INTENSITY

10. Adjust the RETICULE ILLUMINATION control until the reticule becomes barely visible.


AL
SPECTR
MINIMUM
MAXIMUM
RETICULE ILLUMINATION

11. Close the viewport.

12. Stop the instrument counting by pushing the STOP button.


START
STOP
RESET
DUAL SCALER/TIMER

13. Return the radioactive source to its designated storage area.

CAUTION
RADIOA
MATER

X.

REPRINTS OF PUBLISHED ARTICLES

1. "Program Development for New and Emerging Occupations." Journal of Research and Development in Education. (Spring, 1974) pp. 65-79.

2. "Technologists for Nuclear Medicine." Technical Education Reporter (july-August, 1974) pp. 21-26.

3. "Nuclear Medicine Technology" (A three part report). Practical Radiology, March 1973.

PROGRAM DEVELOPMENT FOR NEW AND EMERGING TECHNICAL OCCUPATIONS

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Technological advances have created new educational needs in our society. Large and growing numbers of support personnel are now demanded for doing highly skilled tasks, supervising less skilled workers and gathering data – often without direct supervision from managers and professionals. These personnel are frequently called "technicians" in engineering, agriculture, and medicine; "professionals" or "specialists" in office, business, marketing, and community service fields; and "technicians" or "noncommissioned officers" in the military services.

As these career opportunities emerged, a new kind of education became necessary. On-the-job training, union apprenticeship, vocational education, and the liberal arts proved to be inadequate. In their place, a new type of postsecondary education involving an integrated balance of theory and practice are required. This preparation, frequently called "technical education," includes classroom instruction and laboratory, clinical, or field experiences. It is offered by a great variety of public, private non-profit, proprietary, business, labor, and military institutions. It usually – but not necessarily – involves one to three years of higher education and leads to either a certificate or an associate degree.

Technical education has grown rapidly during the last two decades, but it does not yet adequately serve the 35% to 55% of our youths and adults who could benefit from it. To help address this inadequacy, Technical Education Centers was established in 1965 as an independent, non-profit corporation. TERC is dedicated to the expansion and improvement of technical and occupational education.

TERC's founders placed high priority on curriculum development for new and emerging technical occupations. There are at least a dozen of these important occupations, such as biomedical equipment technician, electromechanical technician, marine technician, and urban development technician. In an emerging occupation, there typically exists an unmet demand for thousands of well-prepared technicians. Because few, if any, educational institutions have high quality programs for preparing such technicians when an occupation first emerges, 50 to 500 schools should establish programs for each new occupation during a decade.

These programs are needed to increase the productivity of public and private employers and to provide students with paths to meaningful careers. Emerging occupations offer students from disadvantaged groups and other parts of the U.S. population realistic career opportunities for individual growth, rapid promotion, and a foundation for continuing education in an expanding technological field. Career education programs in new occupations are thus particularly attractive to community and junior colleges, technical institutes, and increasingly to divisions of four-year colleges and universities.

Between 1966 and 1974, the U.S. Office of Education awarded TERC a series of project grants to develop programs for four emerging occupations. One project has now been completed and the other three are nearing completion. This article describes the program development in the four projects and suggests some procedures and products for program development not only in technical education, but in other kinds of education as well.

A New Kind of Curriculum Development

Typical curriculum development projects create new instructional materials for a single well-established subject such as physics. These materials are designed with stated educational objectives and are tested and refined. In many cases, such projects devote little attention to making certain that educational institutions are actually going to use the materials. It is assumed that a project needs only to develop high quality products and can leave dissemination to commercial publishers who will be attracted by large potential markets.

By contrast, the development of an educational program for a new technical occupation usually presents a more complex research and development problem. The specifications of the occupation typically require that a school initiate a full-time, two-year program with several new technical courses, rather than improve a single existing course. Furthermore, because an emerging field usually is diffuse and rapidly changing, employers do not offer schools a consensus on objectives for program development. New fields also frequently lack instructional materials and experienced instructors and a school or community seldom can afford to develop the materials and to train instructors. Consequently, more than ten years generally elapse between the time employers seek new kinds of technicians and the time educational institutions first graduate such specialists.

TERC concluded that the reduction of this lag required a new kind of curriculum development project, which might be called a program development and demonstration project. Because of the diffuse and rapidly changing nature of emerging occupations, such a project could most effectively and economically facilitate the development of 50 to 500 programs by means of a nationally coordinated research and dissemination effort. The components of this effort are portrayed in Figure 1, the "TERC Model for Designing, Developing and Establishing a New Educational Program." (See pages 68-69.)

The steps that an educational institution takes to establish a program are shown across the top of the model. These include awareness/interest, feasibility study, program design, program start-up, ongoing program operation, and ongoing evaluation and revision. To assist schools with these steps, TERC implements a program development process including the five major kinds of activities shown across the bottom of the model.

A project begins with a national survey of occupational needs and educational resources. Based upon survey results and the ongoing guidance of employers, a project then develops program planning materials, instructional (system) materials, and guidelines for student personnel services. Throughout these activities, employers and professional associations are intensively involved to assure career relevance. School administrators, instructors and students are similarly included to assure educational relevance. This involvement, in turn, encourages the widespread implementation of the project's products, shown across the middle of the model and described in more detail below.

Specific tactics employed in each of TERC's program development projects varied according to the technology of the emerging occupation, its labor market, and the educational institutions with which the TERC staff members were working. Since program development of this sort was new, no detailed model was initially posited for the four projects. The model shown here emerged as TERC responded to the common requirements of technical education in electromechanical technology (EMT), biomedical equipment technology (BMET), laser electro-optics technology (LEOT), and nuclear medicine technology (NMT). Since the techniques employed by TERC for many aspects of program development are in widespread use, these will not be elaborated in this article. However, some unique features of each project deserve further comment.

The Electromechanical Technology Project

Electromechanical technicians deal with a broader scope of technology than do traditional specialists trained in either electronic or mechanical technology. They install, maintain, and repair complex industrial machinery incorporating mechanical, hydraulic, pneumatic, electronic, optical, and thermal devices. After an occupational survey in 1966, the U.S. Office of Education awarded a series of grants to TERC for a program development effort in this new occupational field.

According to the occupational survey, the traditional lines separating electronics and mechanics needed to be eliminated so the electromechanical technician could be equally at home in both of the technologies. The challenge was to teach both technologies in only two years. Since many principles that appear in one technology are also found in the other, the EMT Project staff chose to use a series of ten "Unified Concepts" as the conceptual framework for curriculum development. The resulting curriculum permits mutual support among the several courses and thereby facilitates learning. Such a system focused attention on technical concepts as contrasted with special applications of these concepts.

The materials for teaching the unified concepts were developed as a series of semester-length courses, so that they could be easily incorporated into existing school schedules. The organization of these courses during the first year provided the coordination required to present and integrate the unified concepts. In the second year of the curriculum, the student's technical comprehension and skills were strengthened through application of the basic concepts already learned.

The staff tested the materials with students at Oklahoma State University and then had them tried in several other schools. The materials were also critiqued by more than 40 technical experts. To further evaluate curriculum effectiveness, the project staff consciously established open – mainly formal – lines of communication between students and faculty at Oklahoma State. This effort resulted in much valuable information.

The EMT instructional materials, including 33 laboratory texts and instructors guides have now been published by the Delmar Publishing Company. A series of workshops and conferences were held throughout the country to familiarize users with the EMT materials. Influenced by these dissemination techniques, seventy educational institutions had established EMT programs by June of 1973 and were using some or all of the materials developed by TERC.

The Biomedical Equipment Technology Project

Complex biomedical equipment, such as electrocardiograms and artificial kidneys, is increasingly being used to improve medical research and the diagnosis and treatment of patients. A serious need consequently developed for a new type of technician who could maintain, calibrate, repair, and operate this sophisticated equipment. Human life frequently depends on the knowledge and skill of these technicians. Yet in 1966, only two civilian schools and two of the U.S. military services were preparing biomedical equipment technicians. To rectify this shortage, the U.S. Office of Education awarded a series of grants during the period 1966-1974 to TERC for BMET program development.

Based on an occupational survey, the BMET Project staff envisioned a curriculum that would prepare a technician who combined knowledge of biomedical equipment and an understanding of anatomy, physiology, biochemistry, and patient care. The preparation of such a technician would have required an integrated curriculum similar to that developed by the EMT Project. After program development began at Springfield (Massachusetts) Technical Community College (STCC), however, some staff members began to question the need for an interdisciplinary technician. Although hospitals provided a huge *potential* job market for these technicians, the *current* BMET jobs were to be found mainly with manufacturing firms and repair service companies requiring electronic technicians with a specialized knowledge of biomedical equipment.

The staff had further reservations when a second pilot school, Texas State Technical Institute, decided not to transplant the STCC program, but instead to develop its own curriculum. These reservations were strengthened at a conference of representatives from ten American and Canadian educational institutions with BMET programs underway or being planned in 1969. Each institution intended to develop a program somewhat different from the others in response to its own unique constraints.

The BMET Project staff then shifted its strategy to developing products for flexible assistance to every educational institution seeking to initiate or improve a BMET program. These products included:

1. A collection of BMET laboratory modules,
2. A program planning and curriculum guide,

3. A compendium of both existing and planned BMET programs,
4. An annotated bibliography of BMET educational materials produced by TERC and other organizations,
5. An analysis of BMET tasks by selected criteria,
6. Recruitment brochures for potential BMET students, and
7. A "Sourcebook of Working Papers" concerning problems and possibilities in BMET education.

The project's staff also created an information clearinghouse to assist the network of institutions and individuals interested in BMET education. By facilitating the exchange of information and materials, the clearinghouse encourages interaction among the individuals in the network. An "interactive network" results. Because the clearinghouse periodically revises the compendium describing all BMET educational programs, it also obtains up-to-date information from those concerned with BMET education throughout the nation.

The BMET Project staff monitors the information flows to and from the clearinghouse in order to identify both problems and successes in BMET education. The staff then initiates workshops to explore these problems, and prepares case studies to document several successful programs.

Forty schools have already implemented BMET programs with TERC's assistance, and about twenty more are considering initiating programs within the next two years. More than 2,000 individuals throughout the country have contributed to or benefited from the BMET project at last count in May, 1973.

The Laser Electro-Optics Technology Project

The first laser was made operational in 1960 and applications grew rapidly after that. Once employers were able to purchase laser equipment at a reasonable price, they required well-prepared technicians to use this complex and potentially dangerous equipment. A few employers sought technicians who would work mainly with lasers but most wanted personnel who could perform a variety of fabrication, calibration, and testing tasks with optical and electro-optical equipment as well. To meet the urgent need for program development in this field, the U.S. Office of Education awarded TERC a series of grants during the period 1968-1974.

After an occupational survey, the LEOT Project staff decided to develop materials which could be used in optical and electro-optical programs as well as for laser technician education. The Project's staff also concluded that the materials available were either too academic or too simplistic for use in technician training. With the assistance of an advisory committee comprised largely of employers, the staff then designed a series of instructional modules which were further developed and tested with the help of Texas State Technical Institute faculty and students.

Each of the more than 100 instructional modules developed includes measurable objectives and a laboratory exercise supportive of these objectives. A modular format was adopted so each module could be used either autonomously or in combination with others. This allows educational institutions to choose from among the modules so each school can select a mix appropriate to its local manpower needs and institutional constraints. It also has made the materials attractive to instructors in other technologies and in physics. With the series of modules nearing completion, 45 schools have indicated an interest in the entire series and an additional 400 schools in portions of the series.

The Nuclear Medicine Technology Project

Since World War II, radioactive isotopes have been increasingly used for medical diagnosis and, to a lesser extent, for therapy. As the practice of nuclear medicine expanded, physicians and physicists involved began to need well-prepared technicians to measure radionuclide doses, position patients, operate sophisticated apparatus, and maintain records of radioisotope use. To respond to the technician needs in this critical health field, the U.S. Office of Education awarded TERC a series of grants for an occupational survey and program development, demonstration, and dissemination during 1968-1974.

The occupational survey identified fifty programs conducted by one or more hospitals, each program training one to three NMTs per year. Only three programs were discovered which included affiliations with education institutions, even though most of the physicians and physicists surveyed indicated a strong preference for such programs. Affiliation with schools both improved the quality of programs and reduced their costs.

The 53 then-existing programs for training NMTs varied greatly in length and content. Although part of this variation was due to the special constraints upon each program, substantial variation resulted from the fact that six different professional societies were seeking to regulate the NMT occupation. In addition, the Council on Medical Education of the American Medical Association wished to coordinate the process of accrediting NMT educational programs. The coordination of efforts among the societies had to be agreed upon before effective program development could take place.

After the NMT Project staff, based in Cambridge, Massachusetts, completed the occupational survey, it used the contacts acquired during the survey to begin acting as a facilitator of cooperation among the societies. The staff asked the AMA Council on Medical Education to obtain cooperation among the societies in sending representatives to a TERC-financed workshop to develop an instructor's guide. Five of the six societies agreed to assist. The sixth society initially refused, but later joined the development effort to make certain that its viewpoint was not eliminated from the field.

Meeting in a workshop, the representatives agreed on the content for an instructor's guide. They then obtained formal approval of the guide from each of their societies. The AMA Joint Review Committee completed the process by agreeing that this document be recommended for use by educational programs seeking information supplementary to that available from the AMA for program approval.

The NMT Project staff acted as facilitators in other ways as well. During the 1969 occupational survey, the staff discovered that the University of Colorado Medical School was developing an associate-degree program with the Denver Community College and fourteen hospitals. Although TERC had had no role in the development of this program, the staff decided to publicize it in a case study. As the only program of its size in existence, it automatically became a model. When other educational institutions developed associate-degree programs, TERC wrote case studies about some of them as well.

The NMT Project staff also organized a clearinghouse and developed products similar to those created by the BMET Project. This clearinghouse has provided information and services to educational institutions and hospitals planning to establish affiliations for NMT programs as well as to hospitals seeking to improve their existing programs. By May of 1973, the clearinghouse had grown to approximately 1000 users, of whom 30% were affiliated with community colleges, 27% with universities, 32% with medical schools, and 65% with hospitals.

General Insights About Program Development

During the four projects in new and emerging occupations, TERC's staff observed certain patterns in program development. Research into other kinds of educational innovations indicated that these patterns were widespread. Thus, some of the following observations are relevant to any development project which intends to have an impact on educational institutions throughout the nation.

1. *Responding to Field Constraints.* To develop effective programs in many educational institutions, each of TERC's four projects had to employ different tactics. The differences reflected variations in the technology, labor market demands, professional associations, and educational institutions concerned with each occupation. The EMT Project had to unify several technologies; the BMT Project had to assist many institutions to adapt electronics curricula for incorporating biomedical equipment; the LEOT Project had to offer a wide range of modules in response to variations in local occupational specifications; and the NMT Project had to facilitate cooperation among several strong professional societies.
2. *Accepting Local Autonomy.* The independence of individual educational institutions and the professional autonomy of the instructors within them results in evident differences among the educational programs for the same occupation. In most cases, a school will not introduce a comprehensive two-year program which is "not invented here." This unwillingness may be due to provincialism or to genuine and unique local needs. No matter how much a technical education curriculum is praised by professional experts, it frequently is rejected by local administrators and instructors. Therefore, if a curriculum development project expects to impact upon many educational institutions, it must accept the conditions set by each school. These often result in only partial implementation of an "ideal" educational program.
3. *Assisting Local Innovators.* To have the most impact on the development and improvement of many educational programs, a project must seek out and work with local innovators. As documented by L. Allen Parker (1971), innovations in educational institutions, business firms, and other kinds of organizations are most likely to succeed when at least one individual is highly dedicated to the change effort and also has general management capabilities. The best strategy for capitalizing on the energy and talents of such individuals is to expect them anywhere in the nation and to focus on them whenever and wherever they are identified by surveys and clearinghouse operations. These operations alone are all the support many local innovators need to develop or improve their programs. An active clearinghouse can provide local innovators the moral support of knowing that they are part of a national movement with a place to turn to for assistance.
4. *Developing Modular Materials.* Since local innovators will generally not adopt an entire two-year curriculum, or even all the materials for a course developed elsewhere, a project serves the field best by developing materials in modules which can be used flexibly by many educational institutions. The development of modular materials also

facilitiates the updating of those parts of a curriculum which become obsolescent each year as a result of technological change. Modular materials permit each school to build its own curriculum using quality building blocks. This approach has the added advantage that some instructors in programs outside the field of a particular curriculum development project will use individual modules from the project, thus expanding the usefulness of the project's output.

5. *Involving Both Teachers and Developers.* Two of TERC's projects initially employed technical educators who both wrote the materials and taught the courses in which their materials were used. It was assumed that developers who taught using their own materials would develop more effective materials. At the end of the first year in each of these projects, however, there was concern that the successes being achieved might be due to the personal characteristics of the developer-teachers rather than the content of the materials. Each project then decided to confine its staff to developing and revising instructional materials and had other technical educators test the materials. Development of materials was often subcontracted to individuals outside of TERC, or to the staff of other TERC projects with specialized expertise.
6. *Recognizing the Limits of Evaluation.* The evaluation of individual modules was successfully executed using performance objectives, criterion reference tests, and validation with a sample from the target population. The *formal* evaluation of entire course or entire programs, however, proved to be impossible. Three of the projects did attempt such evaluations by means of confidential case studies and student questionnaries. But these mechanisms were frequently so threatening to technical educators and students that further cooperation with educational institutions would have been unlikely if TERC had persisted in their use.

   In contrast, the projects discovered that *informal* evaluations which occurred during confidential case studies, workshops, and consultations did result in significant revisions of courses and programs. (Henry M. Brickell (1964) obtained similar findings during his survey of the innovative efforts by developers and educators at the elementary and secondary levels in New York State.) The involvement of employers and students in the workshops and confidential case studies proved a good method for prodding educators to keep their programs up to date, especially if job placement opportunities were threatened. Placement in a decent job with multiple career options is *the* pragmatic criterion for effectiveness in occupational education.
7. *Encouraging the Interaction of All Concerned with a Field.* Informal interactions were found to be vital only to effective evaluation but also to effective dissemination. Brickell found the same to be true for New York educators and the National Center for Educational Research and Development (1969) corroborated this finding during a national survey of superintendents. Most educators of all sorts appear to distrust published research reports and speeches at conventions. To learn about innovations, they instead rely upon informal conversations. In the case of TERC's projects, informal interactions during the surveys, workshops, and clearinghouse operations were also important in identifying local innovators and obtaining assistance from employers.

   The vital role of informal interactions in the development and diffusion of innovations is elaborated by L. Allen Parker (1971). This doctoral thesis also explores the foundations and implementation of TERC's strategy for facilitating such interaction as a means to change in America's decentralized educational system.

Suggested Products of Program Development

Twelve products are suggested for a development, demonstration, and dissemination project which intends to impact upon educational institutions throughout the nation. The priority to be placed on each product is determined by a field's technology, labor market demands, professional associations, and the educational institutions concerned. Available time and financial resources might also limit a project from developing all of the following products.

1. *Survey of Needs and Resources.* A national survey is recommended to determine what needs to be done in a field and to discover the materials and people available in the nation as resources for program development. In the case of occupational education, the *needs* include the estimated number of graduates required by the nation's employers each year, occupational specifications, any programs and materials which must be developed for instructional purposes, and qualifications of appropriate faculty and staff. The *resources* are the network of programs, materials, faculty, staff, professional associations and employers involved in the given field. To encourage later contributions for employers and experts in the field, the survey report concludes with a section containing signed critiques of the report from leading employers and experts.
2. *Information Clearinghouse.* Having identified the needs and resources of the network, the project can begin matching some of the resources with some of the needs through a clearinghouse. As new needs and resources appear, these are also included in the clearinghouse, which becomes the basic information center for both the project and the nation. An effective clearinghouse operation involves more than passive collection and dissemination of information. Requests and information inputs must be monitored to identify emerging patterns of needs and resources. When a pattern emerges, the project's staff and appropriate members of the network in the field must be alerted so that decisions can be made regarding necessary changes in the project.
3. *Compendium of Educational Programs.* The resources survey and the clearinghouse operations can identify educational programs which are in operation or are being planned. Descriptions of these are then compiled into a compendium which anyone interested can use to discover who is doing something about the given field of education. Because every program in the nation is included, no educator feels unrecognized. After learning about other programs through the compendium and discussions at workshops, some educators will begin to improve their programs. For the compendium to be effective as an informal prod to improvement, it must be updated periodically.
4. *Case Studies.* From the resources survey and data collection for the compendium, a project's staff can identify unusual educational programs if any exist. Case studies are then undertaken to ascertain the steps used for planning these programs, the kinds of obstacles encountered, the methods of overcoming obstacles, and the reasons for unresolved issues. If a study unearths important facts which are confidential, the case can be presented with other case studies as an anonymous example. A thorough study of an existing program also assists the

project's staff in developing formal and informal administrative guidelines for new program implementation.

5. *Program Planning and Curriculum Guides.* Based on information gained during the survey, the clearinghouse operations, and preparation of case studies, a project can develop a program planning and curriculum guide. This document, or collection of documents, alerts administrators to factors which must be considered when deciding whether to implement a program. It also provides information on such considerations as student and faculty selection, formation of an advisory committee, facilities necessary for conducting a program, and procedures for obtaining the ongoing involvement of employers. An extensive section of the guide includes one or more suggested course sequences, detailed course outlines, laboratory activities, and a description of facilities, equipment, and costs. As with the survey report, this guide can conclude with a section of signed critiques from employers and experts in the field.
6. *Instructional Modules.* The needs survey usually exposes a lack of quality instructional materials for some or all aspects of a field. A project then undertakes or subcontracts the development of these materials. Employers need to be intensively involved in the development process and students in the testing and validation of its products. Because few educational programs will adopt all of the products, modular materials which can be adopted as autonomous units best serve potential users.
7. *Bibliography of Instructional Materials.* For those planning or improving educational programs, the project also develops a bibliography of instructional materials developed by any and all organizations. The bibliography includes annoted descriptions – not evaluations – of the materials. It can also describe laboratory equipment of various manufacturers.
8. *Workshops.* National and regional workshops are vital for training instructors and administrators who are implementing or improving a program. Guides and clearinghouse operations alone are frequently not sufficient. At these workshops, no single activity is more important to educators developing new programs than the chance for informal conversations. To enhance the informal interactions, the project's staff purposely invites educators from operating programs and those planning programs, as well as concerned employers. When a project encounters a serious problem in program development, it can also organize a workshop for participants in the field, including employers, to seek solutions.
9. *Recruitment and Career Materials.* Among other problems a workshop can address is the definition of career options for an occupation. When an occupation is emerging, it is likely to be fluid in its characteristics and generally unknown to educators, students, parents, and even employers. If the occupation can be placed in a cluster with similar occupations, guidelines and objectives can be provided for designing educational programs which offer many career options. Recruitment materials and articles in journals and trade magazines can then publicize the occupation's existence and the kind of education it requires.
10. *Counseling and Student Assessment Guidelines.* In conjunction with the development of career options, a project can formulate guidelines for counselors and mechanisms for student assessment of educational programs. Unless a curriculum development project activity encourages the involvement of counselors in program development, TERC has found

that such involvement is likely to occur only as an afterthought – if at all. The conspicuous inclusion of counseling guidelines in planning materials helps to focus attention on this area. Among other things, the guidelines can include sample questionnaires and other communications mechanisms for obtaining student assessments of the program. Similarly, sample follow-up surveys of graduates can encourage the faculty to seek feedback from former students who are discovering the applicability of their formal education to on-the-job practices.

11. *Sourcebooks.* As those concerned about a field grope for solutions to its problems, the problems and proposed solutions can be documented in a "Sourcebook of Working Papers on Problems and Possibilities." Disseminated in a loose-leaf format, sections of a sourcebook can be inserted, updated, or deleted as the field develops. Another kind of sourcebook combines elements of the compendium, the bibliography, and the program planning guide into one reference.
12. *Follow-up Questionnaries and Materials.* As a field of education continues to develop, it frequently changes so that survey data and some materials become obsolete. Although a project's staff monitors clearinghouse requests and inputs to identify some of these changes, the staff can also make periodic investigations to discover other changes. Follow-up surveys of educators, employers, and *program graduates* can be used to complement clearinghouse operations.

Need to Maintain Program Relevance

New trends identified by follow-up surveys often require changes in programs to maintain their relevance to the field. Whereas other components of a program development project for new occupations can be created and implemented during five to seven years, the maintenance of relevant programs requires development and follow-up mechanisms which must continue after termination of research funding for the project. As TERC's four research and demonstration projects draw to a close, educators, employers, and professionals are expressing concern about the continuation of these services needed to maintain relevance and growth.

They stress the fact that technical education programs must be updated periodically if they are to remain relevant to student's and employers' needs. In the case of emerging technical occupations, such changes may be necessary every year or two for many years until an occupation becomes well-defined. New occupations are also likely to have manpower needs which increase for decades before becoming stabilized; consequently, additional educational programs must be established each year for some length of time.

If the nation can afford nothing else, the concerned participants in the interactive network for the projects have stressed that ways must be found to continue *active* clearinghouse operations. This would include collection of new data and materials and dissemination of information and documents. More important to *active* operation, however, would be the organization of workshops on serious problems in the field and the initiation of proposals or projects for the development of new instructional modules to replace those which have become obsolescent. Workshops might also be needed to train instructors in the use of new materials. Depending on the field involved, such clearinghouse operations might be continued either by the organization which executed the original development project or by some other research and development organization.

TERC has been exploring possible ways to continue clearinghouse operations. Some possible solutions have been proposed and two are being tentatively implemented, but this is the remaining major challenge of program development projects for new technical occupations.

When this challenge is met, a proven model will exist for develping and improving quality educational programs for emerging technical occupations. These quality programs will prepare youths and adults for careers as technicians and comparable specialists who work with professionals, business managers, government employers, and labor executives to improve the nation's goods and services. These educational programs will satisfy many students because they provide skill in performing practical tasks and insights into why things happen. Moreover, quality programs will offer many disadvantaged youths a realistic path to remunerative and respectable careers.

The development and improvement of these quality programs thus is critical in a society experiencing rapid technological change. We have the functional model within our reach. The availability of financial resources for further program development is and will be the controlling factor in meeting urgent present and future needs of new and emerging technical occupations.

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Technologists for Nuclear Medicine

Huey D. Barnett, Hillsborough Community College in Florida

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TECHNOLOGISTS FOR NUCLEAR MEDICINE

Physicians need support personnel for work with radioisotopes in diagnosing dangerous diseases.

During the last two decades, a growing number of physicians and physicists became involved in the emerging field of nuclear medicine. They developed methods by which they could administer a radioactive solution to a patient and then observe where the solution concentrated in the patient's body. With these new techniques, physicians have improved their ability to diagnose many ailments, especially cancer. They also found ways to use radioactive materials in the treatment of certain localized diseases such as thyroid cancer. As nuclear medicine became more widespread during the 1960s, the technology spawned a growing demand for a new kind of support personnel–the nuclear medicine technician or technologist.

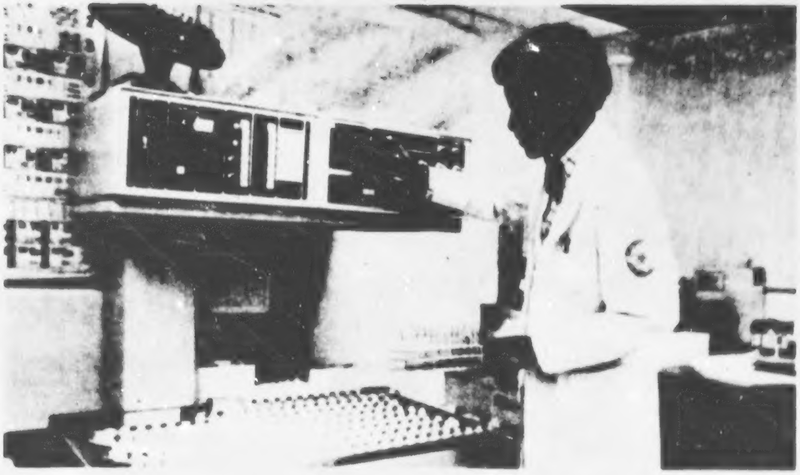
SUPPORT PERSONNEL NEEDED

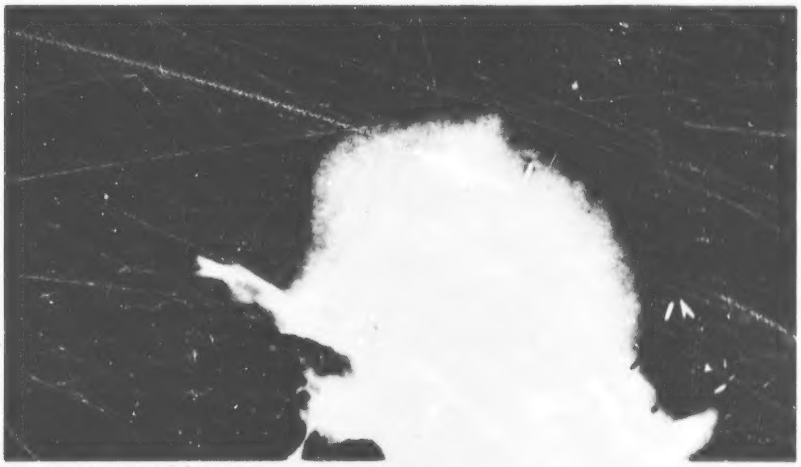
These technologists, "NMTs" for short, work closely with physicians, physicists, and patients in several different ways. They mix the radioactive materials, known as radiopharmaceuticals, which are given to patients orally or by injection. As the material settles in the body, the particular organ or area under investigation is studied with a scanning device operated by the NMT. A variety of electronic equipment must be used including imaging systems, video tape recorders, and computers. Unlike X-ray work, some nuclear medicine tests may last as long as several hours. Hence, the NMT has a lot of patient contact and must be responsive to patient needs and anxieties while at the same time maintaining professional standards. A patient might, for instance, ask the NMT how a nuclear medicine procedure works. The NMT is also responsible for radiation safety, which requires meticulous care in handling potentially lethal materials.

Until 1970, NMTs were trained, either formally or informally, almost entirely by the hospitals where they were needed. According to the national survey entitled *Development of Career Opportunities for Technicians in the Nuclear Medicine Field*, at least fifty U.S. hospitals had formal NMT training programs in 1969. Almost half of these involved collaboration among two or more hospitals, but only three programs were affiliated with schools. Some large hospitals located their training in independent nuclear medicine departments because they had sufficient resources and personnel involved. In contrast, many hospitals housed NMT training in departments of radiology, pathology, or internal medicine which had first devised or used nuclear medicine procedures.

Since the most common procedures had been developed in radiology departments, the NMT trainees were mainly radiologic technologists (X-ray technicians). When nuclear medicine was located in the other types of hospital departments which had originated certain practices, other kinds of allied health personnel, such as medical laboratory technicians, retrained to be NMTs. It is not surprising, therefore, that the U.S. had a diversity of hospital-based training programs ranging from three months to one year in length. The graduates of these programs sought recognition from one or more of several professional societies with an interest in the new field.

As the demand for NMTs expanded, increasing pressure came from the American Medical Association and the nuclear medicine field itself for the development of minimum standards for training NMTs. Two broad categories of training programs emerged. Some nuclear medicine practitioners preferred to continue the hospital-based programs which retrained existing allied health personnel. With the AMA acting as a catalyst, the societies concerned with these programs moved toward an agreed upon set of minimum standards, and one year training programs resulted. Approximately 150 of these programs now exist in the United States and Canada.





On the other hand, a growing number of hospitals have established collaborative programs with community colleges and technical institutes. These programs, which combine clinical training in the hospitals with theoretical classes at the schools, are two years in length and generally admit students with little or no previous hospital work experience. Twenty-five or more of these programs have been initiated in the United States and Canada. One of the first collaborative programs to be founded was that of Hillsborough Community College (HCC) in Tampa, Florida.

COLLABORATION CREATES A PROGRAM

In 1965, Don Ward, then Chief NMT at Tampa General Hospital, started a program to retrain certified radiologic technologists to become NMTs. Although his program met with success, it was limited to three students per year–an insufficient number to meet the growing demand. After securing backing from the hospital's Director of Radiology, J. Carlisle Hewitt, M.D., he met with HCC personnel in 1969 to propose the development of a two-year degree program for NMTs.

Being well received, he proceeded to plan the program. One of his first steps was to visit the new NMT program at the Community College of Denver. This program, described in the case study referenced at the end of this article, provided a model of collaboration with a variety of hospitals in offering clinical experiences to community college students.

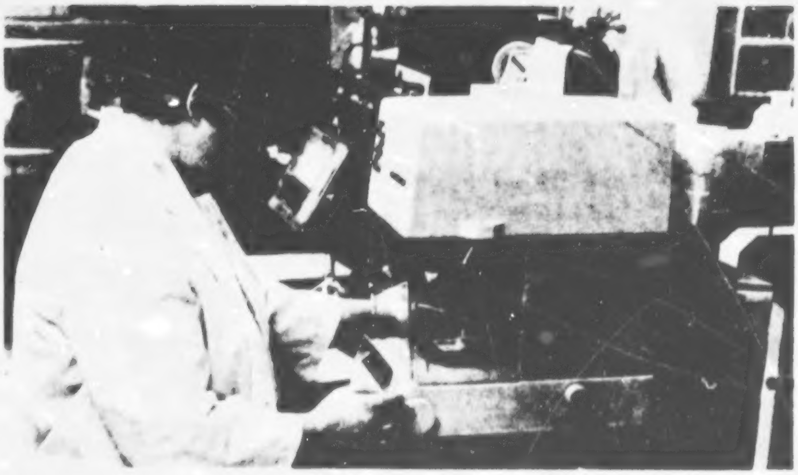
A curriculum design for the HCC program was then sketched and an informal advisory committee was established consisting of administrators from the college and Tampa General Hospital. A Total of $135,000 was granted by the Florida State Department of Education's Division of Vocational-Technical Education to support the program over a three-year period. The first NMT class entered in the fall of 1970.

THE CURRENT PROGRAM

As the program is designed today, students are offered a theoretical and practical understanding of nuclear medicine technology. The first three quarters are devoted to coursework at the college. The remaining twelve months of the program are devoted to full-time clinical training which involves rotation periods through all four of the affiliated hospitals.

Two courses are included in the first semester which introduce students to hospital procedures and settings. If a student finds hospital work not to his or her liking, the student can then leave the program without having lost a year. *Interpersonal Relationships in Health Care* considers anxiety, stress, crisis, and death, as well as professional ethics and the relationship of the practitioner to the patient. In *Introduction to Patient Care*, students observe operating room, diagnostic, and nursing procedures in the hospital.

Several other courses concentrate on nuclear medicine technology. *Introduction to Nuclear Medicine* provides a brief history of nuclear medicine and examines the basic concepts of radioactivity, radiation detection, instrumentation, radiation safety, and the production of radiopharmaceuticals. During this introductory course, field trips are taken to the affiliated nuclear medicine training facilities. *Nuclear Physics* includes the basic concepts of atomic, nuclear, and radiation physics; and *Nuclear Instrumentation* is a practical course concerned with the use of such instruments as the Geiger-Muller counter, imaging cameras, scanners, and radiation monitoring devices. *Radiation Safety and Health Physics* presents the rules pertaining to the possession, use, and disposal of radioactive materials and teaches students



how to handle such materials safely.

For related preparation and associate degree credit, the NMT program requires four additional courses. These include career communications, physical science, applied mathematics, and human anatomy and physiology.

To supplement the second-year clinical experience, students return to the college once a week for a three-hour seminar in *Nuclear Medicine Methodology* aimed at relating the theoretical to the clinical aspects of nuclear medicine technology. These seminars stress the rationale and techniques of nuclear medicine procedures. During the year, each student chooses a special topic in nuclear medicine, searches the literature and writes a paper about it, which is presented to the class. The fourth quarter seminar involves the study of radiation damage to living systems.

With special permission, students may be exempted from any NMT course if adequate knowledge of its subject matter can be demonstrated. The faculty plans to initiate night courses and refresher courses for already-employed NMTs seeking professional advancement. However, interested potential participants in such courses are scattered over a large geographical area, so the course logistics are still being worked out.

OBSTACLES OVERCOME

The current program is the result of continuous evaluation and modification. Beginning a new program in a relatively untested area presented several difficulties which could not be anticipated. After the first year, parts of the program were totally revised to solve some of the problems which had emerged.

Of the fifteen students selected for admission into the first class, seven dropped out within the first year. Reasons for leaving the program included insufficient mathematical skills, demanding part-time jobs, and problems in adjusting to hospital settings. In one or two cases, the dropouts "just didn't like" the program.

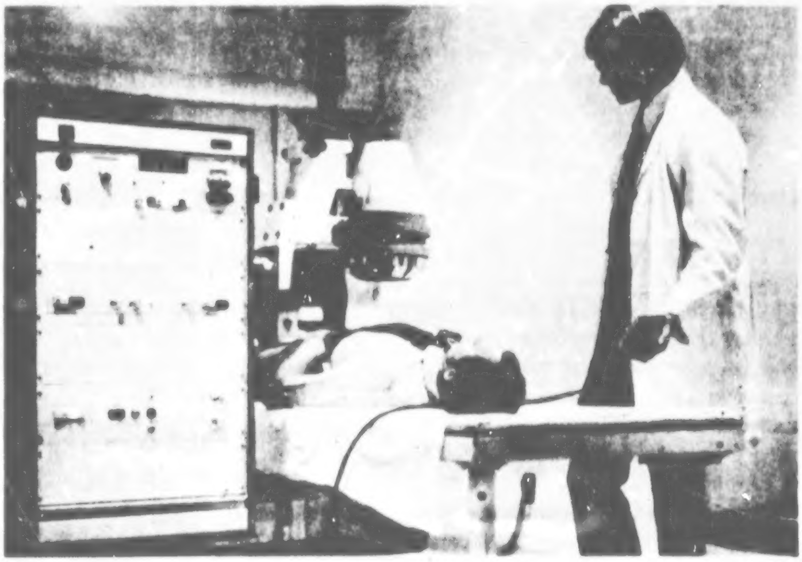
To remedy this situation in later classes, the faculty developed mechanisms for screening applicants more carefully. An entrance examination including mathematics, reading comprehension, and a vocabulary test was devised. Intense interviews were used to ascertain the strength of each applicant's interest and the appropriateness of his or her temperament for hospital work. Unless a student had a superior academic record, he or she was discouraged from taking a part-time job during the program. Using such screening procedures, the program now admits twenty students each year, and has no more than one or two dropouts per year.

Scheduling the courses and the clinical experience also posed another problem. Originally the program was structured so that the courses would parallel the clinical experience with some students working at the hospitals in the morning and some in the afternoon. It soon became evident, however, that one group of students was gaining much more laboratory experience than the other because the hospital's morning workload was much heavier than its afternoon workload. In contrast, the other group had more energy for doing well in their courses. Furthermore, most of the students in each group required time to adjust to the clinical work since they had had no previous hospital experience and lacked a theoretical orientation to nuclear medicine.

After the first year, the program was revised to overcome these difficulties. The already-mentioned courses entitled *Interpersonal Relationships in Health Care* and *Introduction to Patient Care* were devised to complement the theory course work. By moving the practicum to the end of the program, students not only had a better idea of what they were doing, but also had an opportunity to participate in a hospital's full workday cycle.

NMT IN DEMAND

Because the students graduating from the HCC program have both a theoretical foundation and practical laboratory experience, they are very



much in demand. Hospital administrators and physicians frequently contact the program seeking its graduates. Consequently, the faculty has not found it necessary to make special efforts to place the graduates in jobs. Each student usually has several job opportunities from which to choose. Senior students seeking employment are aided, however, by a seminar on how to construct a resume and how to handle a job interview. The rest is left to the student as a learning experience.

To make certain that HCC's NMTs remain in demand, the faculty undertakes periodic follow-up surveys of program graduates. Continuing contact is also maintained with an advisory committee of hospital employers and technologists throughout the region. Using the resulting feedback, the faculty continues to update the NMT curriculum.

NEW DEVELOPMENTS

This feedback will become even more important when construction is completed on HCC's new laboratory, which is specially designed for the NMT program. To our knowledge, it is the first NMT laboratory in an educational institution. Associate degree NMT programs in community colleges and technical institutes have generally been unable to afford the costly equipment required to train NMTs. Instead, programs have relied upon collaborative arrangements with hospitals for teaching students how to use nuclear medicine equipment and to carry out diagnostic procedures.

The special laboratory will offer HCC an opportunity to provide this training in a more structured manner with less dependence on hospital schedules. This will permit the NMT students to learn how to use nuclear medicine instruments and perform diagnostic procedures before they begin working with patients in the hospital. During the hospital-based practicum, they will then be able to devote more of their time to caring for patients. This more patient-oriented practicum will help assure the continued relevance and high quality of HCC's program in nuclear medicine technology.

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